POWER

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ELY C. HUTCHINSON, *Editor*

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Human Traffic

These forewords would be incomplete without discussion of the practice among some manufacturers of trafficking in the engineering brains and experience of their competitors. It is quite all right for concerns to keep abreast of their competitor's developments if they cannot lead them. But the way in which it is sometimes done is highly unethical.

I refer to the practice of enticing key men away from good jobs with excellent expectation of security by offering salaries disproportionate to the service rendered. The men themselves are tempted by the apparent recognition of their value and unless they are unusually wise they are swayed by the compliment into leaving a steady and congenial position. Some companies even hire men at high salaries with the deliberate intention of releasing them when their special knowledge has been absorbed.

The old employer, although he could have avoided the trouble by a more liberal employment policy, will probably survive the loss. The new employer certainly does not intend to suffer in the transaction. The man, as I said before, unless unusual, will probably be the real sufferer.

Wise men will think twice and carefully evaluate consequences before succumbing to the blandishments of the boss's competitors.

EDITORIALS

Short-Sighted Savings

Some companies, as a part of their retrenchment programs, are proceeding on the assumption that their power departments, having been brought up to a reasonable degree of efficiency, can be entrusted safely to less-experienced and lower-salaried subordinates, thus saving the salaries of these department heads. Others have gone a step further and, totally blind to the potentialities of the power plant for savings or waste, and have for the present abolished direct supervision and control over their power generation and power services. As a result many power superintendents, plant engineers and chief engineers have joined the ranks of the unemployed.

The first procedure involves an injustice to the individual who has rendered loyal and competent service and is penalized for having applied the principles of good management in training his subordinates. But aside from the human aspect, both policies are economically unsound and short-sighted.

Never was there a more opportune time to survey the power problems of industry, searching out lost motion and waste and putting into effect improvements in operation that will reap substantial returns when normalcy returns. But such work requires experience and competence such as is possessed by many of the very men whose services are being dispensed with.

Retrenchment is the order of the day. It is both necessary and commendable, but common sense demands that it be applied intelligently. Apparent savings must be weighed against hidden waste. Especially is this true of the power department.

Depreciation Rates On Power Equipment

Among the several elements of fixed charges—such as interest, depreciation, insurance and taxes—none causes more difficulty and confusion than that of depreciation. On industrial power equipment, in particular, the depreciation rate is often fixed without proper consideration of all factors. An example is the common practice of "depreciating" steam prime movers on the basis of a life of fifteen or twenty years. It is a well-known fact that engines and turbines, particularly the former, generally continue in good operating condition for a far longer period. The customary answer will be that the "depreciation" period must actually include obsolescence and that engines built today will certainly become obsolete in twenty years through the development of new types of much greater efficiency.

This argument may be sound in the case of engines installed in plants generating power only. If, however, the engine in question is to be used only as a "reducing valve" to generate byproduct power and if (as frequently happens) the exhaust is at all times less than the demand for low-pressure steam, the efficiency ceases to have any economic significance. In such cases the primary factor of obsolescence disappears and the probable life of the business or the actual wearing life of the machine (whichever is least) will determine the depreciation rate to be used.

Another factor often overlooked, but very important on a long-life basis, is the interest on the sinking fund. With an estimated life of five years it may be sufficiently close to charge off one-fifth of the cost each year. With a twenty-year life such a procedure introduces a serious error.

Allowing six per cent interest on the sinking fund, the depreciation rate for a twenty-year life is only two and seven-tenths per cent, instead of five per cent. Sinking-fund tables for all life periods and all interest rates are widely available; there is little excuse for the common failure to use them in computing the fixed charges on power equipment.

Boiler Fuel Oil for Diesel Engines

Among some diesel engine operators the belief is prevalent that the use of boiler fuel oil as an engine fuel is accompanied by excessive maintenance which offsets the gain due to the lower cost. An article in this number of *Power* describes an experience with this fuel which, due to poor engine adjustment and improper operation, was anything but satisfactory. But by correcting these faults, operation was improved sufficiently to make the use of this type of fuel economical.

An engineer, learning of the difficulties encountered at this plant before the various changes were made, would probably be convinced that boiler fuel oil could not be used to advantage in that diesel engine. The subsequent success with this fuel should make it evident that judgment based upon plant experience should not be made without a thorough knowledge of all phases of the plant's operation.

It also becomes clear that when purchasing a diesel engine the type of fuel which will be used should be specified. In this it is not sufficient to merely state the viscosity of the oil at a given temperature. The Conradson residue and the field from which the oil is obtained should also be stated. This then gives the engine builder a deserved opportunity to design and adjust his engine so it will successfully and economically burn the specified fuel.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

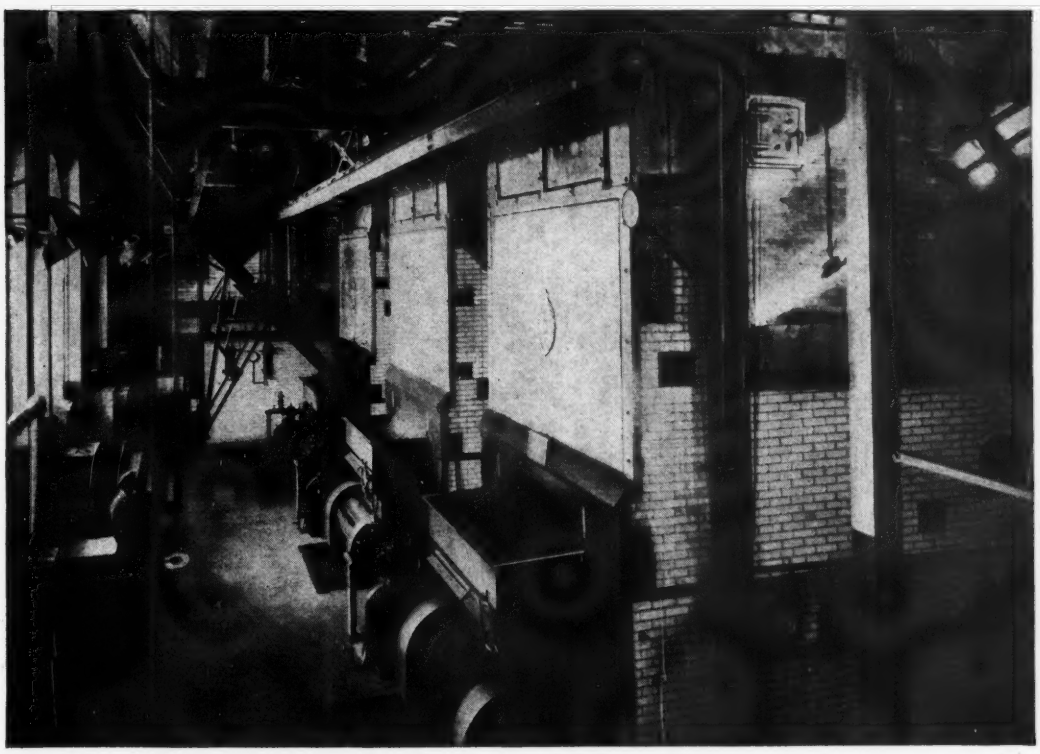


Fig. 1—Travelling-grate stokers under water-tube boilers burn Welsh anthracite screenings

Operating Costs Reduced $34,000 Annually in Royal Victoria Hospital

By D. F. GRAHAME
Chief Engineer
Atwood Limited, Montreal

By a complete revamping of power service equipment and systems the Royal Victoria Hospital in Montreal, Canada, is now saving approximately $34,000 yearly in operating costs. About $27,000 of this saving is in coal alone, due to decreased consumption, better boiler efficiency and the ability of properly selected firing equipment to handle a cheaper grade of coal

THE Royal Victoria, one of the largest general hospitals in the Dominion, was founded in 1893. At that time it consisted of one main building heated by a gravity hot water system, supplied by hot-water boilers in the basement.

In 1900 it became necessary to construct a separate power house. This plant went through a number of alterations from time to time, the final arrangement including 5 hand-fired return-tubular boilers served by a 120-ft. square brick chimney, 4 converters for the hot-water heating system, turbine-driven circulating pumps and other auxiliary equipment.

There was also a 20-ton motor driven ammonia compressor, a 100-kw. vertical compound generating set, and a 75-kw. motor-generator set.

Some of the newer buildings were supplied with alternating current for both light and power direct from the power company's mains.

Old Plant Outgrown in 1929

By the year 1929 the hospital had grown to an institution of 750 beds and the annual coal consumption of the steam plant approached 9,000 tons, so that the question of economy had become important. In addition, the boilers and auxiliaries were in a run-down condition, having seen some twenty years of service, so that extensive replacements would have been necessary in any case.

Some thought was given to the question of constructing an entirely new power house and turning over the whole of the old power house to the laundry department, which was badly cramped for space. However, on looking into the question further,

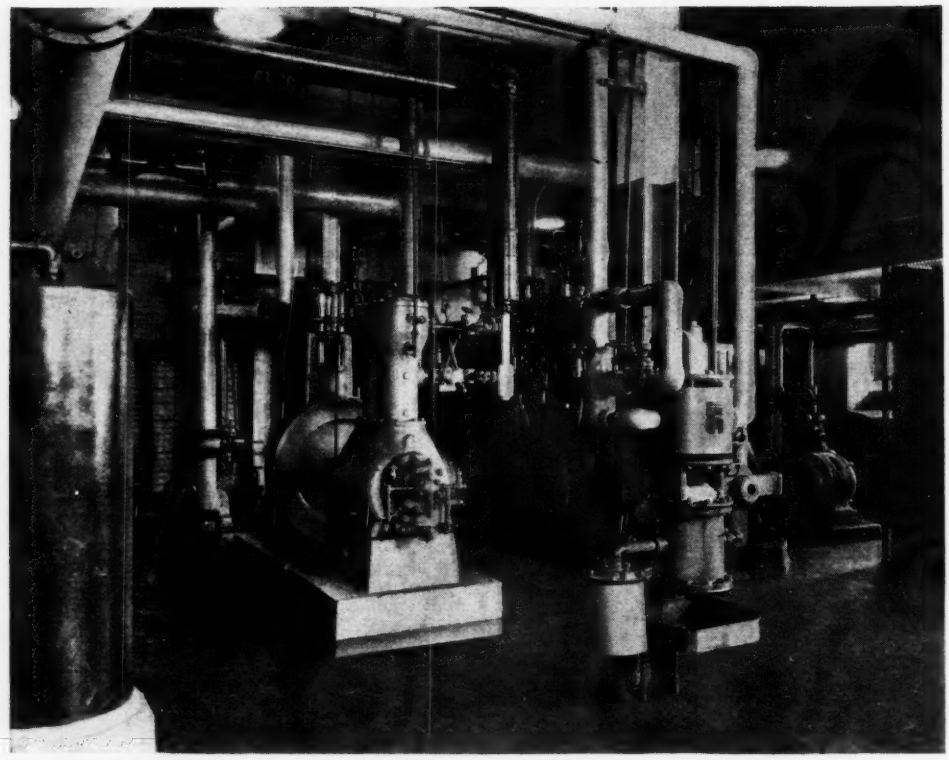


Fig. 2—In addition to a 100-kw. vertical compound engine generating set the engine room contains a motor-generator set, two twenty-ton refrigerating compressors (1 steam driven), turbine driven feed pumps and other equipment

it was found desirable to construct a new laundry building and to revamp the existing power house—a stone building 42 ft. x 100 ft. with a height from the boiler room floor to the bottom of the roof trusses of 37 feet. The boiler and engine rooms had a ceiling height of only 20 feet, however, as the entire second floor was occupied by the laundry.

New Boilers Installed

The entire laundry floor was removed, providing space for three 4,500-sq.ft. straight-tube boilers as well as a future unit of 7,000 sq.ft. The boilers are of the cross-drum type, set with front headers 16 ft. above the firing floor. They are designed for a working pressure of 200 lb., the safety valves being set at 175 lb.

A new 150-ft. x 8 ft. 6 in. concrete chimney was constructed, the original chimney being inadequate for the draft requirements of the new boilers.

Travelling Grates for Welsh Anthracite Screenings

In addition to American and Novia Scotia bituminous coals and American buckwheat anthracite, there was available in Montreal a reasonably constant supply of Welsh anthracite screenings. The usual custom is to mix a certain amount of bituminous slack with the screenings to promote ignition and to act as a binder for the fines.

Having in mind the satisfactory results which had been obtained when burning American anthracite screenings on the forced-draft chain-grate stoker with special arch designs, stokers of this type were installed for burning the Welsh screenings. These stokers would also handle bituminous coals satisfactorily with a slight change in arch arrangement. Each stoker has a grate area of 90 sq.ft. and has five damper-controlled air compartments. Stoker drive is by separate steam engines direct connected to the stoker gear boxes. The arch arrangement consists of a short ignition arch at the front with a long sloping flat arch at the rear, the effective throat opening being five feet.

Coal Handling Equipment

Coal delivery is by trucks which dump into a hopper at the north end of the building, the coal being fed into the boot of a gravity-type conveyor. This elevates the coal and distributes it over the length of the 150-ton parabolic bunker. Coal is fed to the stoker hoppers by a one-ton hand-propelled weigh larry.

Ashes are removed from the rear of the stokers by hand and are fed into a vacuum-type ash conveyor which discharges into a steel tank located on a 20-ft. high stub of the old chimney. From this tank the ashes discharge to trucks by gravity.

Engine Room Contains Auxiliaries

A 23-ft. x 68-ft. extension to the engine room was constructed to provide space for all heaters, pumps, blowers, etc., as well as for a new steam driven ammonia compressor, an additional motor generator set and other equipment.

All make-up for the boilers, as well as hot and cold water for the laundry, is treated in a zeolite type of water softener located in the engine room. An open type deaerating feed water heater raises the feed temperature to 200 degrees.

Two 60,000 lb. per hr. turbine-driven single-stage centrifugal feed pumps draw their supply from the heater. The delivery pressure of the pumps is controlled by differential pump governors. Two feed lines are provided, one connected to the boilers through thermostatic feed regulators and the other a stand-by line with hand control valves. Two turbine driven blowers, each with a capacity of 40,000 cu.ft. per minute, supply combustion air at $4\frac{1}{2}$-in. pressure.

A 20-ton steam-engine-driven vertical ammonia com-

pressor was provided to work in conjunction with the existing 20-ton motor driven compressor to supply refrigeration for the existing brine system for the Ross and Maternity buildings, and also to operate an ice tank of five tons daily capacity.

This tank is located on the site of the original machine shop and supplies all ice (formerly purchased) required by the hospital.

An 11-in. x 11-in. x 12-in. direct-acting air compressor, mounted on a column in the engine room, supplies air to the laundry and to the main building.

Boiler Room Instruments and Flow Meters

Each boiler is equipped with a meter panel with boiler meter which records steam flow, air flow, and flue gas temperature and integrates the steam flow. Seven-point draft gages are also mounted on the panels, showing air pressure in each stoker compartment; also furnace and uptake draft. A recording and integrating flow meter is connected to the feed line which also records feed temperature.

Recording and integrating flow meters are also installed on the steam lines to the main building, Ross Pavilion and laundry.

Welded Piping System

All high-pressure piping is extra heavy with Van Stone flanges on sizes 2½ in. and over. Oxyacetylene welded joints were used wherever possible. All feed lines are of extra heavy brass and hot and cold water lines are of standard weight brass.

Heating System and Heat Balance

Building heat is supplied in part by forced circulation of exhaust heated water and in part by live steam. It would undoubtedly have been desirable to heat all the domestic water by means of low-pressure steam in the power house, as this would have made possible the use of considerable exhaust steam during the summer months. While this could not be arranged for because of the heavy expenditure for hot water mains, space for a future domestic water heater was provided in the power house.

During the heating season, a large portion of the output of the plant is required in the form of low pressure steam for the convertors, so that for about seven months of the year, it is possible to utilize all the exhaust from the auxiliaries, the 100-kw. engine generator, and the steam driven ice machine.

During the summer months, the use of the steam-driven ammonia compressor will be restricted to the hours when the laundry is in operation, and the demand on the laundry heater is sufficient to absorb the exhaust steam from the unit. At other periods the steam required by the feed-water heater will be sufficient to prevent waste of exhaust from the feed pumps, blower turbine, and stoker engines.

The following table gives the hourly distribution of steam for an average winter day:

	Lb. per Hour
Low-pressure steam to converters and heaters	20,000
High-pressure steam to laundry	2,500
High-pressure steam to Ross and Maternity buildings	6,000
High-pressure steam to main building	12,500
	41,000

Engine Operated in Winter

The original portion of the hospital including the Ross Pavilion is wired for 115-volt direct current, but the later additions, namely the Nurses' Home, Maternity Hospital, and also the laundry, use alternating current for light and power.

The peak load of the hospital with no steam driven units in operation is 375 hp., but by operating the engine generator, steam driven ice machine and brine pump, etc., this load is reduced to about 200 hp.

The direct current equipment consists of the original 100-kw. engine generator and 75-kw. motor generator,

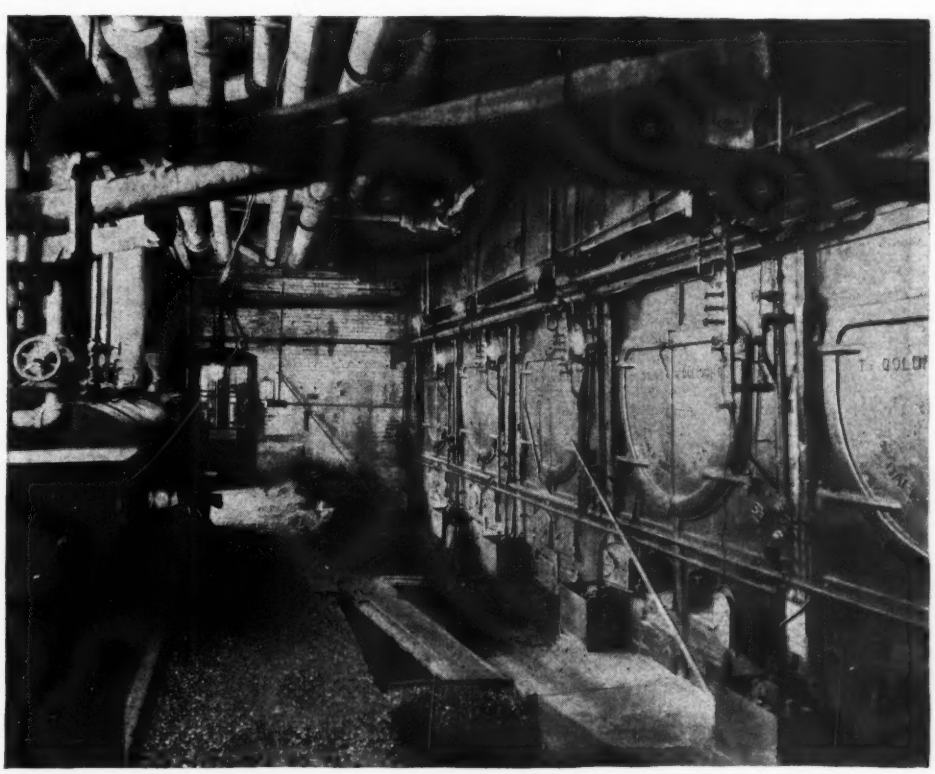


Fig. 3 — Based on the same steam output, a unit evaporation of 8.22 lb. (9.25 lb. for new plant) and coal costing $7.10 per ton ($4.50 for new plant) these old hand-fired boilers were wasting $27,200 yearly in fuel

plus a new 150-kw. motor generator. The new machine was provided because the peak d.c. demand is somewhat in excess of the capacity of the 75-kw. unit, making it necessary to operate the engine generator at frequent intervals during the summer months and thus waste a considerable quantity of exhaust steam.

As the rates charged by the public utility are extremely low, it is more economical to purchase energy during the non-heating period than to generate power by steam.

Sixty-cycle, 3-phase, 4,000-volt power is supplied by the utility at the high tension board in the power house. From there it is distributed by underground cables to three groups of transformers located in underground vaults at the power house, Maternity building, and Main building, being stepped down at these points to 500 volts for power and 110-220 volts for light.

Saves $27,200 on Fuel Bill

The coal consumption of the old plant averaged about 8,800 short tons per annum. During recent years number one grade of American buckwheat and a certain amount of Scotch anthracite buckwheat were used, the average cost per ton being $7.10, making the annual cost of coal $62,500.

The maximum daily coal consumption was 60 tons with an average for the month of January of 40 tons per day. During the summer months, the coal consumption dropped to about 10 tons per day.

Prior to the commencement of building operations, a boiler test was run on the old plant. This test showed an actual evaporation of 8.22 lb. The fuel cost per 1,000 lb. of steam with coal at $7.10 per ton, worked out at 43.2 cents.

Based on an annual coal consumption of 8,800 tons, the total steam production was about 144,000,000 pounds.

Operating records from the new plant show an average evaporation of 9.25 lb. With coal costing $4.50 per ton the fuel cost of steam per 1,000 lb. is 24.3 cents, making a saving of 18.9 cents per 1,000 lb.

Assuming the same total annual steam consumption, this represents a gross fuel saving of over $27,200.

Actual coal records for the month of January, show a consumption of 1,280 tons for January, 1931, costing $9,112, as compared with a consumption of 1,040 tons, costing $4,685, for January, 1932. This makes a nominal saving of $4,427 for the month. The unusual mildness of the winter no doubt affected the steam demand to some extent, but, on the other hand, the load was increased due to additional buildings in use so that these figures should give a fair indication of the savings made.

Total expected annual savings based on the foregoing and upon actual records may be summarized as follows:

Saving in laundry soap and soda, als o boiler compound (due to water softener)	$3,700
Saving due to the manufacture of ice	2,800
Reduction in boiler-room staff	1,140
Saving in coal cost	27,200
	$34,840

Fig. 4—General arrangement of new plant

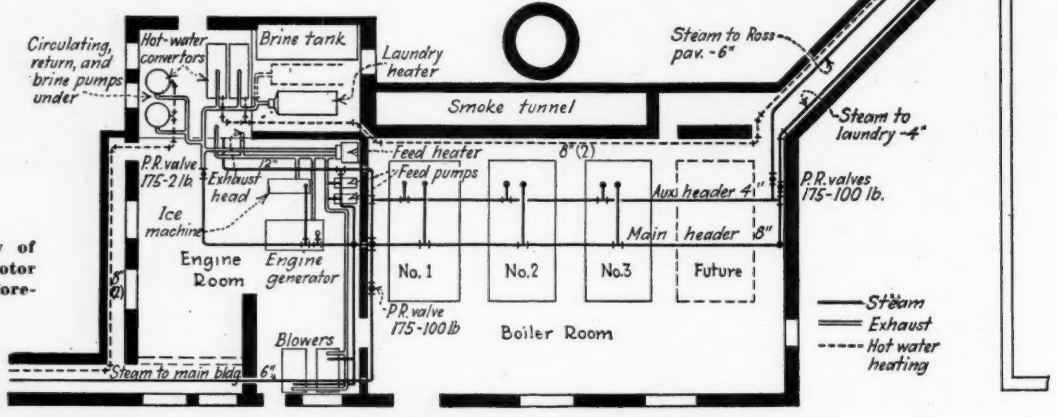
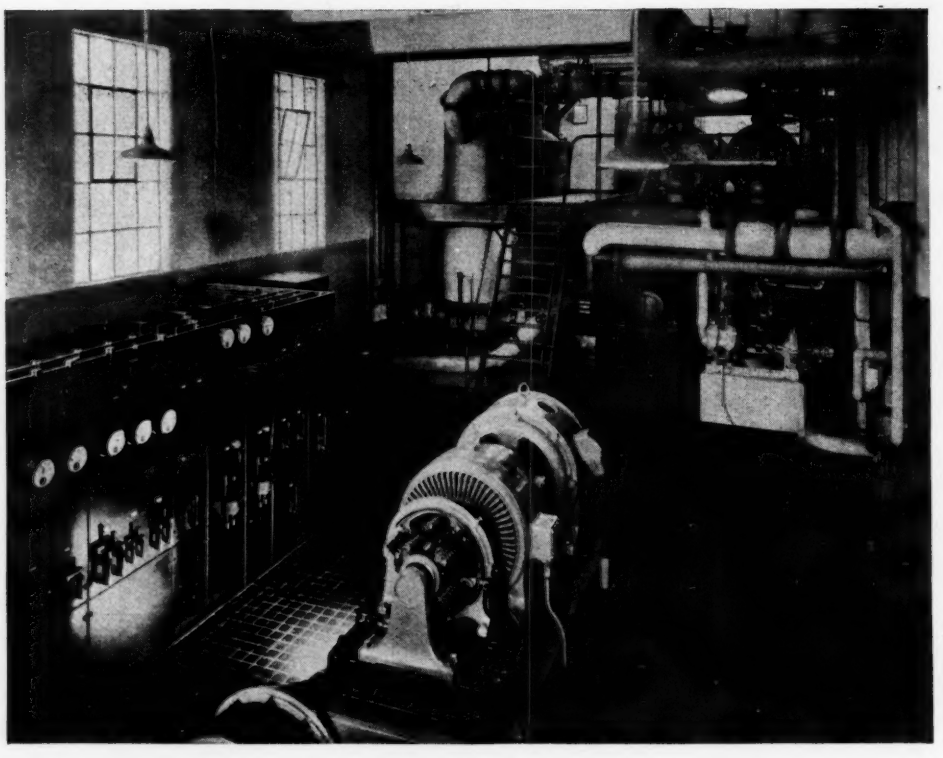
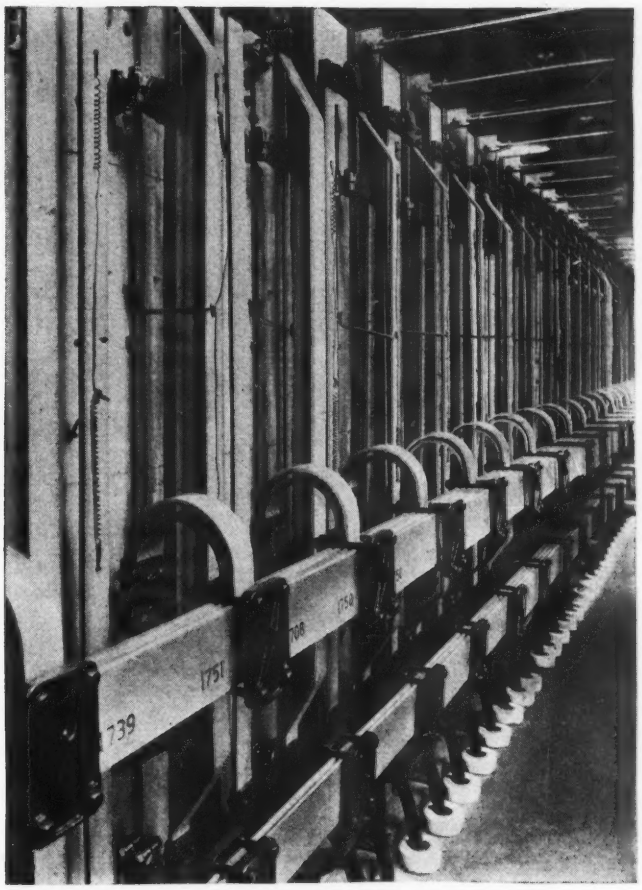


Fig. 5—Another view of engine room with motor generator set in foreground





This installation of flat aluminum busbars operates at 600 volts, 15,000 amp. in a rotory-converter substation

ALUMINUM CONDUCTORS For High-Capacity Electric Circuits

How aluminum conductors in the form of flat bars, tubing and structural shapes have been applied for bus construction in power houses, substations and industrial plants

By F. R. DALLYE
Aluminum Company of America

ELECTRICAL CONDUCTORS of pure aluminum have been in use in the United States since about 1898. Stranded cable was the first product commercially available and only a few years elapsed before aluminum was being fabricated in the form of bars or rods and used for busbars in industrial plants.

Today, aluminum electrical conductors for bus construction are used in three major forms: flat bar, tubing and structural shapes, the last-named including channel sections, angles and other shapes. Flat bar is by far the most commonly employed for both alternating and direct current, on switchboards, in substations, and in industrial plants.

Flat bars are easy to form, as well as simple to join and support. Over comparatively narrow ranges, current capacity may be increased by the addition of bars in multiple. On the other hand, flat bars offer little resistance to bending in the plane perpendicular to the major axis of the cross-section. They are relatively inefficient for transmitting heavy currents unless special configurations or interlacing are resorted to, in which case the support fittings become somewhat complicated and expensive.

Tubular electrical conductors are generally utilized in outdoor substations and often in generating stations or special equipment. Their form gives a structure equally rigid in all planes, and since the strength and rigidity are high for the total weight, long spans may be safely depended upon. From the standpoint of corona loss, which may obtain in high-voltage work, tubing is the most satisfactory conductor, and the alternating-current resistance of economical sizes is low. The type of fittings commonly accepted becomes costly with the larger sizes of tubes, which is probably the reason that 3,500-amp. alternating current is about the upper limit in general practice for tubes of any material. Alternating-current capacity may be improved somewhat by increasing the wall thickness of the tube, but the maximum value appears to be reached at about 0.8 in. for aluminum and 0.6 in. for copper.

The newer type of conductor using two pure aluminum structural channels has already been used in outdoor substations, generating stations, industrial plants and on switchboards. This conductor has high strength structurally in all planes, thereby allowing the use of long spans even where substantial short-circuit forces may be encountered. It has also a low skin effect and, due to the ventilation of the inside surfaces, a high

current capacity per unit weight of material. For direct-current work this high current capacity is the main electrical advantage, since skin effect is not concerned. Most of the problems of assembling channel shapes are the same as for flat bar and are simple and economical. Large channels can be economically used for high currents with an efficiency nearly equal to the smaller sizes with but little increased proportional cost.

A pair of 8-in. channels weighing only 14 lb. per foot, will carry 6,400-amp. 60-cycle alternating current with the generally accepted temperature rise of 30 deg. C.

A study of the effect of the physical properties of aluminum on the size and type of conductor and support spacing reveals some interesting facts.

The specific gravity of aluminum is 2.70, and its conductivity about 60 per cent of the I.A.C.S. An aluminum conductor the direct-current resistance of which is the same as copper has a cross-sectional area of about 160 per cent of the latter, but its weight is less than half. If a maximum temperature rise rating is considered, the aluminum cross-section need be only approximately 127 per cent and its weight less than 40 per cent. This method of rating is the most commonly used, particularly for alternating-current conductors.

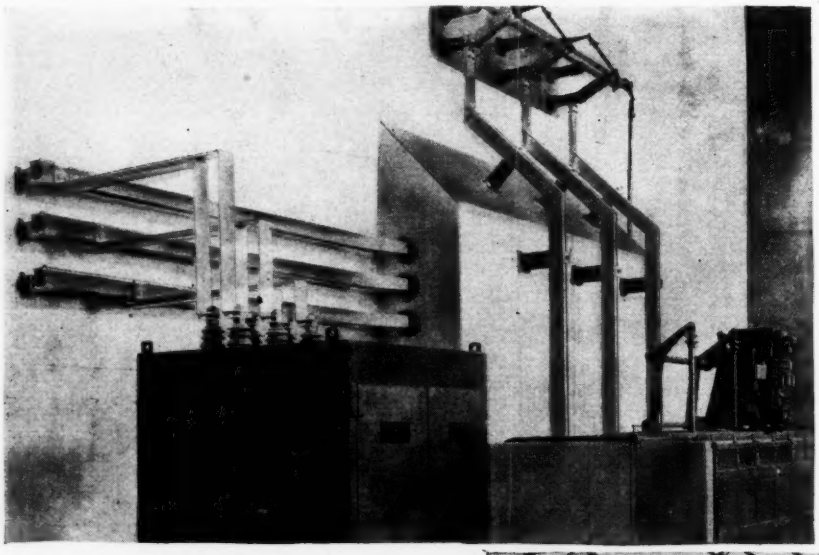
In flat or tubular buses where short-circuit forces are not controlling factors, the light weight of aluminum allows the use of longer spans between supports. Where short-circuit forces control this spacing, the supports may be located at least as far apart as for copper, because the required additional cross-section area makes up for the lower tensile strength of aluminum, 12,000 to 24,000 lb. per square inch, according to the temper. Occasionally, high strength is of more importance than conductivity. For such cases strong aluminum alloys are available, with conductivities ranging from 30 to 50 per cent of copper and tensile strengths as high as 55,000 lb. per square inch.

Joints may be formed either by gas torch or electric arc welding. However, since welding equipment is not available on most jobs, this method is seldom employed. Clamps or through-bolts are commonly used to make a standard overlapping or butt joint.

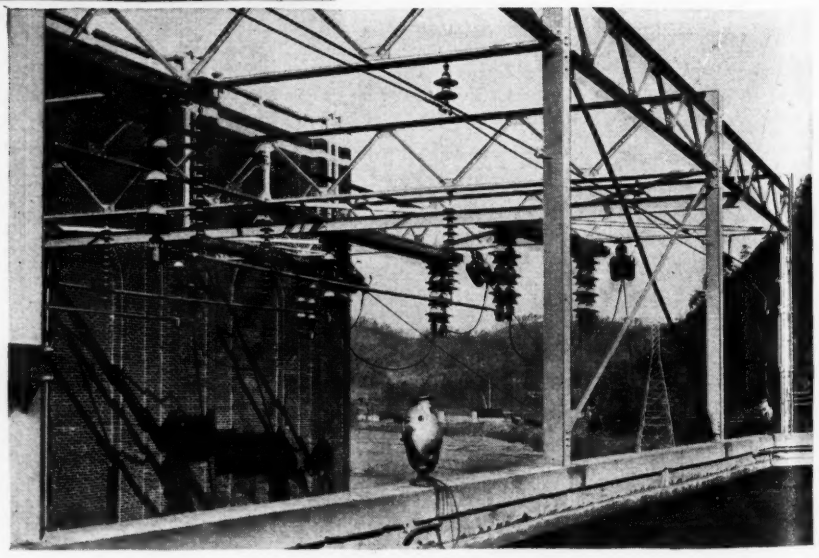
The efficiency and life of bolted joints depend upon unit pressure, contact area and whether voids exist between surfaces. A joint under sufficient pressure, possessing the proper contact area and proofed against moist air, will maintain its original resistance almost indefinitely. Pressure is one of the most important factors in securing low initial resistance. Large contact areas permit greater variations in pressure due to temperature changes without increase in resistance.

Joints made with through-bolts are generally more desirable than joints made with clamps. The bolts in all cases should be of large size to avoid overstressing when large wrenches are used. A distinct advancement in bus construction is the use of cupped spring washers designed to insure correct initial tension in the bolt and to retain this value during temperature changes.

The practice of greasing un-



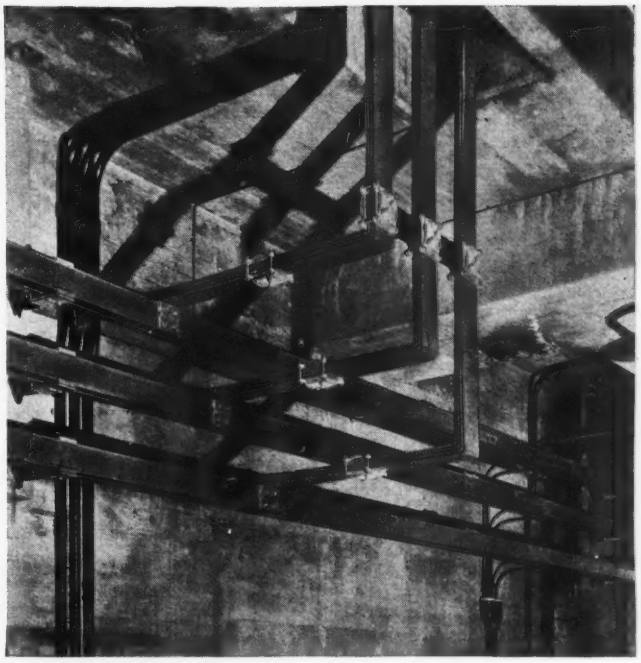
Both flat aluminum busbar and channel-shaped aluminum conductors are used in this installation. The aluminum structural-channel conductors have high strength structurally in all planes, thereby allowing the use of long spans even where substantial short-circuit forces are encountered. In this installation flat bars are used to make the connections to the channel-shaped busbars



Aluminum tubular conductors installed in the outdoor substation at Calderwood hydro-electric plant in Tennessee. Tubular conductors are generally used in outdoor substation, but they are often utilized in generating stations on special equipment

soldered contact surfaces before cleaning is desirable for both aluminum and copper, because it decreases initial resistance and preserves the joint by sealing it against oxidation or corrosion. Before assembly the contact surfaces should be reasonably clean. They should then be coated with a liberal amount of vaseline or some modified petrolatum base compound, such as No-Ox-Id Grade A special, which is more tenacious and less liquid at elevated temperatures. The surfaces should then be abraded with a scratch brush or emery through the coating and the joint bolted together without removing the coating. The efficiency of this method has been definitely proved under a variety of conditions.

The resistance of aluminum to many of the corrosive atmospheres met in industry makes its availability for electrical conductors of added importance to designing engineers. Sulphur and its compounds, some of which are the most common substances met in industry, have no appreciable effect on aluminum conductors. And, although strong alkalies will attack them, their resistance to acids is an important reason for the extensive use of aluminum busbars in the plating industry. These characteristics are, of course, advantageous where busses may be installed in foundries, steel mills, chemical plants and central power stations.



Flot aluminum bars connect to channel-section busbars in Chute-à-Caron power house in Quebec

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Direct-Current Excitation Of Wound-Rotor Motors

By W. W. LANKTON

OF THE several methods of correcting power factor a low-voltage direct-current generator, such as used for electroplating, to supply power to the rotor of a wound-rotor motor is probably the most novel. In our plant there is a 500-hp., 440-volt, three-phase, wound-rotor motor. We connected a two-commutator. 6-volt, 1,500-amp. direct-current generator in series with the rotor of this motor, as in the figure, to correct the power factor. The direct-current machine is separately excited and the two armature windings are connected in series to give 12 to 15 volts. The armatures have ample capacity to carry the rotor's alternating current at 10 per cent slip.

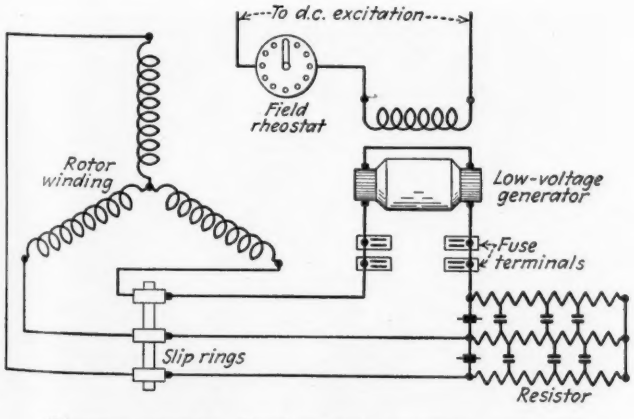


Diagram showing direct-current generator connected in series with rotor of induction motor

In case it is necessary to take the low-voltage generator out of service, or desirable to operate the motor without it, fuse clips are installed in the generator leads in which copper bars can be inserted to complete the rotor circuit around the exciter's armature. In some applications it might be desirable to install a contactor in the armature leads to cut the generator in and out of the rotor circuit. We have found, however, during several years of satisfactory operation with this installation, that contactors and relays are not necessary. There have been only a few occasions when it was necessary to take the exciter out of service, and at these times copper bars were inserted in the fuse clips, thus connecting the rotor directly to the controller.

Anyone making such an application of a low-voltage generator to a wound-rotor motor should consider the load normally carried by the motor. This method of power-factor correction is most effectively applied to motors operating considerably under full load. The current capacity of the rotor windings must also be taken into account.

As to the results obtained with this method of power-factor correction, I have seen the power factor of a feeder carrying a 1,100-kw. load have its power factor increased from 0.65 to 0.75 by putting the exciter into service on the 500-hp. motor. The cost of an installation of this kind may be quite low if the low-voltage generator can be obtained second hand.

On the installation just described the exciter is belt-driven from the motor's shaft. On a 400-hp. wound-rotor motor in our plant that also has its rotor excited by direct-current the exciter generator is driven by a 7.5-hp. alternating-current motor. In this case the exciter motor is started by a contact on the main controller.

Prompted by the discussion in "Readers' Problems" in the Feb. 2, 1932, number of Power, *this article relates the operating performance of diesel plant in Mexico 9,000 ft. above sea level using boiler oil for fuel*

By J. J. McDOUGALL
Globe, Ariz.

Performance of a Diesel Plant Using Boiler Fuel Oil

A CONSIDERABLE difference of opinion exists concerning the economy of using heavy boiler oil as fuel in diesel engines. These differing opinions are due largely to the wide variation in maintenance work that diesel operators have experienced when using boiler fuel oil. The following report of the operation of a diesel plant in Mexico indicates how greatly the amount of maintenance necessary is influenced by the adjustment of the engine fuel-handling equipment.

Fig. 1—Air compressor valves plugged with excess lubricating oil after a few days' operation

The plant contained three two-stroke-cycle valve-in-head scavenging air-injection engines, supercharged to counteract the effect of altitude; two three-cylinder units of 500 kw. and one five-cylinder unit of 850 kw., sea-level rating, guaranteed to deliver this rating in a normal manner at 8,600 ft. above sea-level when burning Mexican fuel oil (Chapapote) of about 8 deg. Baumé.

The service required was for a silver mine having two mills, one of 600 and the other of 250 tons' capacity, a shutdown of either being expensive and the lost output not recoverable. The average load factor was about 70 per cent, allowing one unit to be shut down during one 8-hr. shift. But on the other two shifts, when the crushers and hoists were in operation, a fairly steady rating of 85 to 90 per cent and at least 110 per cent for swings was required on all three units.

The fuel conveniently available was gas-oil at 6c. a gallon and heavy oil containing considerable sulphur at 3c. a gallon. Thus, at the estimated fuel consumption of 80,000 gal. per month, a saving of $2,400 a month was possible if the cheaper oil were used, and as future plans called for another large unit a future saving of about $4,000 a month was indicated.

For a short time, as far as the power plant reports showed, a saving was made; but actually, when the loss of output in other departments due to lack of power was calculated, a loss was incurred far greater than any possible saving due to cheap fuel. For example, the valve failures only cost the power plant $40 and 45 minutes lost time to replace, but due to the conditions existing at the time it actually cost the company about $5,000, because the other units were out of commission and these valves failing in different cylinders of a three-cylinder unit caused it to stall, shutting the plant down. This, according to the manager's figures, caused a loss of $5,000 worth of cyanide solution.

Similar costly incidents caused the owners to hire an outside engineer to see if the troubles could be decreased, because the mine was operating at a loss and no other source of power was available.

When the new engineer took charge of the plant he found the following conditions:

1. The crankshaft of the large unit had broken twice in the past six months, once through the journal bearing next the flywheel and once through No. 2 crankpin; due,

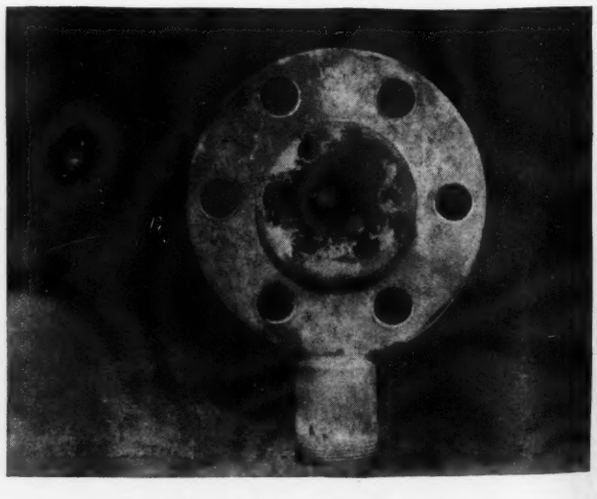


Fig. 2 — Spongy condition of piston rod flange was due either to electrolytic action or from acid in the system. With no acid in the system this trouble largely ceased

no doubt, to bad misalignment and maladjustment of the fuel valves.

2. Wristpin, crankpin and journal bearings failing after short service due to cracking of shells or squeezing out of babbitt. This trouble was caused by either maladjustment of the fuel valve or acid in the lubricating oil, generally both combined, but either alone often caused a failure.

3. Piston heads burning out and rings and cylinder liners wearing rapidly; chiefly caused by maladjustment of the fuel valve.

4. Air-compressor trouble was far more than normal, due entirely to maladjustment of the fuel valve, which required an injection pressure of 1,350 lb. at only 80 per cent rating. When the injection pressure reached 1,000 lb. the suction of the low-pressure stage could be connected to atmosphere instead of to the hot air from the scavenging pump, which would allow about another 8 per cent of air for scavenging the power cylinders, and stop the low-pressure valves from being plugged with excess lubricating oil, as shown in Fig. 1.

5. The lubricating oil, while of good quality, was practically useless for this service, and the generators, switchboard and other electrical equipment was rapidly becoming saturated from the oil vapor. The cost of lubricants was $1,000 to $1,500 a month more than it should have been. This high cost was due to the destruction of the oil by the large amount of gas blowing by the power pistons and which was heavily charged with sulphur gases. Most of the blow-by was due to the condition of the pistons. But there was always some blow-by at heavy load, hence an oil having three times the viscosity at 212 deg. of the cylinder oil in use was tried. This stopped the blow-by except on overloading. When used in the entire system, though it has fifteen times the viscosity of the oil recommended, it almost entirely eliminated oil fog inside the engine and entirely so as far as the engine room was concerned. Though the new oil cost three times as much per gallon, the total cost for lubrication was at least $1,000 less per month. The majority of the lubricating troubles were, however, due to maladjustment of the fuel valve.

6. The apparent damages from sulphur-charged gases were broken piston rods, connecting rods, crankbearings and wristpin bearings, also the journal bearings were corroded, the flanges and bearing faces were eaten away to a similar or greater extent than in Fig. 2, which shows a piston rod removed before it collapsed. The above troubles were at first blamed on the electric generator causing electrolysis, but as the generator bearings were in perfect condition, insulated and well grounded and having their own oiling system, it seemed more reasonable to believe that the trouble was due to the sulphur acids in the lubricating oil formed by the exhaust gas. By eliminating this the majority of the troubles stopped; there were, however, still evidences of corrosion inside the piston rod and wherever a leak occurred between two different metals. As far as could be determined, no other damages to the engine resulted from the sulphur in the fuel, which in some batches ran over 4 per cent. Intercooler coil failures in the injection-air compressors, however, increased rapidly when allowed to draw in exhaust gas.

7. Indicator diagrams, Fig. 5, showed that the engines were not running on the diesel cycle, but on an explosion cycle, and at best conditions the compression pressure varied from 350 to 400 lb. per square inch. They also indicated that the fuel was injected in such a manner as to detonate before dead center, causing a rapid rise of pressure to over 700 lb. at maximum load.

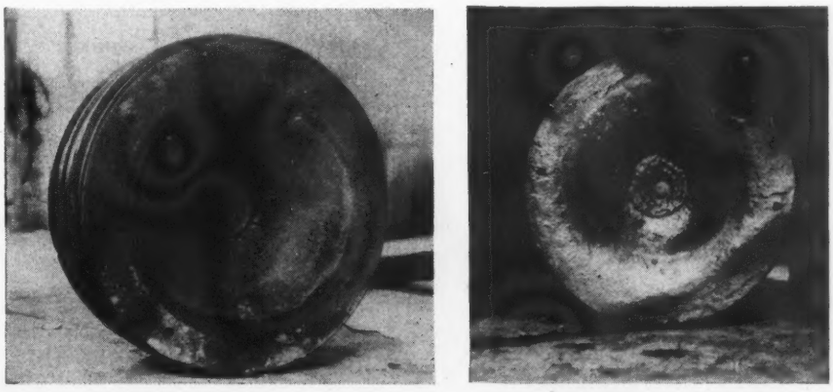


Fig. 4—The piston head at the left is beginning to burn out, and on the one at the right fuel was coking

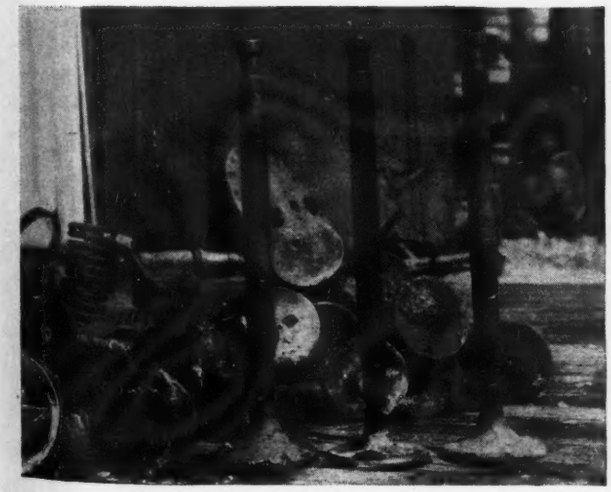


Fig. 3—Slag formed on valves and combustion surfaces because dirty fuel was not thoroughly filtered

Examination of the fuel valves disclosed that every one was set differently from the other and that all settings were incorrect for the oil in use. The atomizing device originally supplied with the engine was not suitable for the heavy oil used, as it allowed the oil to collect around the fuel needle, and when the needle lifted the oil was injected practically in one slug. This splashed on top of the piston head. In case of good compression it caused the piston to burn out, and in case of poor compression formed gummy deposits. Fig. 4 shows this action. The cam roller clearances varied from 0.065 to 0.095 in. (0.030 is normal). The injection pressure for the load was 450 lb. too high, being 1,350.

The engines were overhauled as rapidly as possible. The design of the atomizer and flame plates was changed

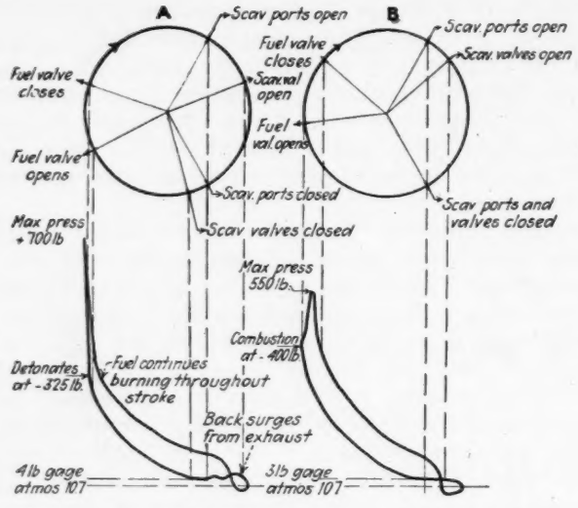


Fig. 5—Indicator diagram *A* shows condition of engine when not adjusted for the fuel oil used. Diagram *B* shows engine performance after changes

to agree with that found successful with 14 deg. oil; the fuel cams were set at about 12 deg. before top dead center, with a clearance between cam and roller of 0.010 in. The cylinder clearance volume was adjusted to 85 per cent of sea level and the supercharging adjustment was entirely eliminated. Due to the frequent splitting of fuel pumps it was decided to heat the oil to at least 150 deg. F. instead of the 100 deg. recommended; also the fuel filters were fixed so as to work properly, for at times large quantities of dirt would cause pump, atomizer and ring trouble. Fig. 3 shows a batch of junked valves coated with slag formed by this dirt.

On starting the engines great improvement was noticed. They developed 80 per cent rating normally and often pulled 85 to 90 per cent for eight hours. Swings of 110 per cent can be handled without stalling, but 80 per cent rating is considered full load. This checks well with the comparison of air in the clearance volume, for now the compression averaged 430 lb., hence the rating expected was $\frac{85 \times 430 + 10.7}{475 + 14.7}$ or 77 per cent. The new adjustments reduced the scavenging air to practically the same gage pressure as at sea level, hence the rating from the scavenging air would be $\frac{10.7 + 3}{14.7 + 3}$ or 78 per cent.

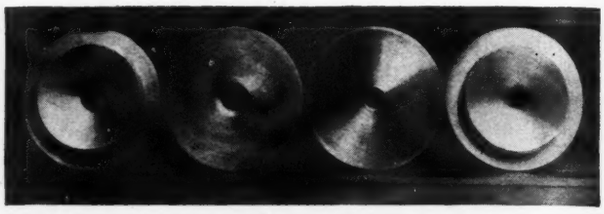
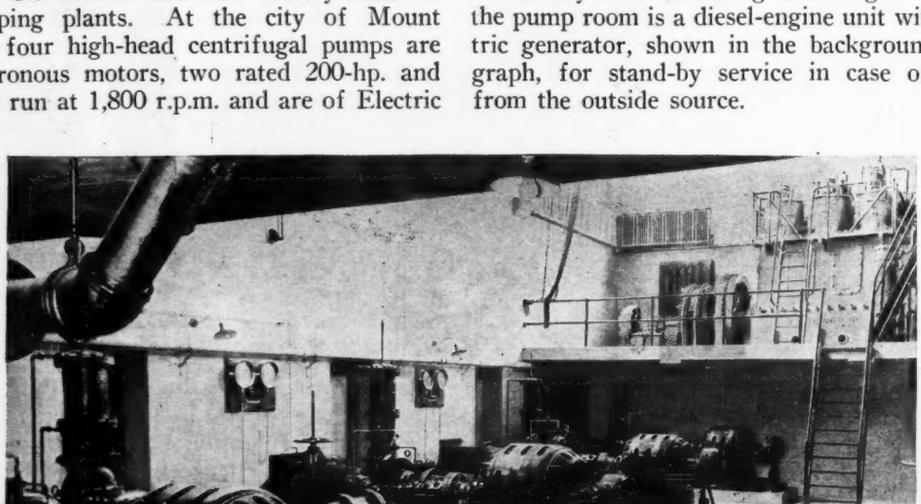


Fig. 6—The original flame plate or fuel nozzle was changed as shown

▼ ▼ ▼

Mount Clemens Pumping Plant Synchronous-Motor Driven

SYNCHRONOUS motors are now widely used in modern pumping plants. At the city of Mount Clemens, Mich., four high-head centrifugal pumps are driven by synchronous motors, two rated 200-hp. and two 125-hp. All run at 1,800 r.p.m. and are of Electric Machinery Manufacturing Co. design. Also installed in the pump room is a diesel-engine unit with 160-kva. electric generator, shown in the background in the photograph, for stand-by service in case of power failure from the outside source.



The Economics of Surface Condenser Selection

By JOHN H. SMITH*

The design and application of surface condensers has become so specialized that a free exchange of knowledge, between manufacturer and purchaser of all factors affecting a proposed installation is essential if best interests are to be served. This article is written with a view to stressing such an exchange of information and emphasizing the importance of an economic analysis

FOR many years two-pass condensers were almost universally used where the surface type was preferred, and selection was often made by rule-of thumb methods. However, in their endeavor to reduce the cost of power generation, power-plant designers were influential in establishing a new era in condenser design and application. Slightly in advance of this period, the single-pass condenser came into being, and while not a "cure-all" it did represent a valuable contribution to the art. Recognition of the fact that a field existed for both types prevented a swing in the opposite direction with equally serious effects upon plant economics.

The Most Economical Condenser

The most economical condenser is the one that shows the lowest annual operating charge, which includes expenditures for auxiliary power, main turbine steam consumption, and fixed charges. Or, if deemed more desirable, each assumed case can be determined on the basis of a relative equivalent investment for the entire installation, in which event the annual expenditures for auxiliary power and main turbine steam consumption differentials are capitalized at the annual rate for fixed charges and added to the initial investment for condensing apparatus. The result in either case will be the same in so far as apparatus selection is concerned.

Since the velocity of the circulating water through the condenser tubes affects all the factors comprising annual operating charges, any analysis resolves into a determination of the most economical water velocity. That is, water velocity affects condenser size, hence auxiliary power charge, and the rate of heat transfer, which, in turn, affects vacuum and main turbine steam consumption.

It is apparent that every factor affecting annual operating charges requires careful consideration. These factors can be classified into three major groups, namely, A—Physical, B—Operating, C—Evaluating.

A—Physical Factors Applying to Surface Condensers:

The principal physical factors are tube length, tube diameter, and tube wall thickness.

In some cases the opinion of the operators will form a basis for procedure, whereas in others the manufacturer will be required to make recommendations. In any event, the maximum permissible tube length should be determined, for usually long tubes work to advantage, both as to initial cost and pumping power.

Tube diameter and wall thickness are usually functions of prevailing water quality, and the operating companies, from experience and opinion, often are committed to a definite size and gage. It may develop, from an analysis, that tubes having other physical dimensions will prove advantageous, in which case the saving incident thereto, if equated against cost of cleaning, will disclose the correct procedure.

Except in very unusual cases, such as water having highly corrosive or abrasive qualities, No. 18 B.W.G. tubes are in general use. In exceptional cases, the purchaser is reconciled to the necessity for using the more expensive and thicker tube walls.

B—Operating Factors:

Under this heading are classified such performance factors as influence the size and capacity of the condenser and auxiliaries and, although wholly a prospective purchaser's responsibility, the manufacturer often finds it necessary to render such aid as is required to establish rational values. They are enumerated as follows:

1. Pumping head, external to condenser friction.
2. Loading or capacity factor of turbine.
3. Turbine water rates at various loads and vacua.
4. Circulating-water temperature chart for year.

*Director of Condenser Division, Alco Products, Inc., and during past 22 years active in condenser design and engineering with several large condenser builders.

5. Maximum permissible quantity of circulating water.
6. Required vacuum performance.

1. *Pumping Head, Exclusive of Condenser Friction* is often specified as external pumping head on circulating pumps. It consists of (*a*) pump suction pipe friction; (*b*) pump discharge pipe friction; (*c*) condenser discharge pipe friction; (*d*) tunnel friction, or intake and discharge water level difference; and (*e*) syphon loss. A typical installation can be pictured and the total pumping head, including condenser friction, analyzed as in Fig. 1.

The prevailing pumping head, necessary to raise water from the inlet level to the discharge flange at the top of the condenser, is the sum of the suction lift, S; suction friction, f_1; static discharge, D; discharge pipe friction, f_2; and condenser friction, C. During this process, flow has commenced in the suction tunnel, so that the level of the river is reduced in the tunnel by the amount of tunnel friction, I. Likewise, when flow is established throughout the system, thus filling the barometric leg, the level in the discharge tunnel is raised above the river level in the amount of discharge tunnel friction, O. The discharge head on the pump is reduced in the amount of the net syphon effect (B—V) and then increased in the amount of barometric leg friction, f_3. Placed in equation from equilibrium established

Total pumping head

$$= (S + f_1 + D + f_2 + C) - (B - V) + f_3$$
$$= S + D + C + F + V - B.$$

Now $S + D = B + T$.

Substituting $B + T$ for $S + D$,

Total pumping head $= B + T + C + F + V - B$,

in which B cancels out and it becomes $T + C + F + V$. In other words, the total pumping head is the sum of the difference of water levels in inlet and outlet tunnel, the condenser friction, pipe friction, and syphon loss.

2. *Loading, or Capacity Factor of Turbine* — Theoretically, definite vacuum differences are justifiable for every change of load on the main unit and for every change of inlet-water temperature for each change of load. To obtain these vacuum changes would require an intricate device, thermostatically controlled, to vary the speed of the circulating pump to obtain the required circulation. Such a device, at the moment, is properly deemed impractical, hence some method whereby a mean average capacity factor, in terms of circulating-water temperature variations, seems a practical solution. Examination of the following assumed conditions over a predetermined range of time and during periods of known water temperatures provides the necessary data for a practical solution. It is essential that the purchaser make a thorough study of the proposed range of loads, the hours of operation at each load, during each month, and a chart, or graph of the monthly water temperatures throughout the year. Undoubtedly, most purchasers can supply such a chart of loading, since it is presumed that the decision to purchase a unit is based on some anticipated loading.

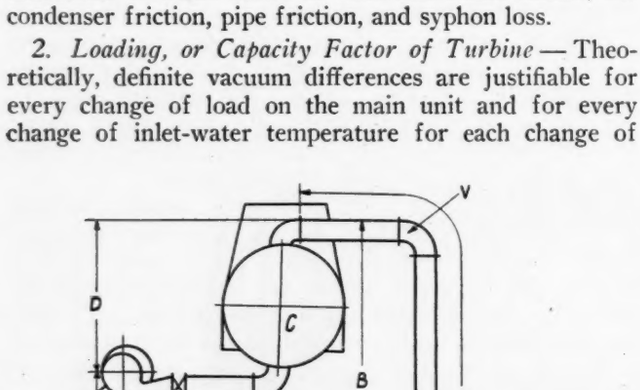


Fig. 1—Typical installation, showing analysis of total pumping head, including condenser friction

I = Inlet tunnel friction loss.
O = Outlet tunnel friction loss.
T = $I + O$ = total tunnel friction loss or difference between inlet and outlet water levels.
S = Suction head.
D = Static discharge head.
B = Barometric head, or syphon effect, never exceeding full barometer.
C = Condenser friction, inlet to discharge flange.
f_1 = Suction pipe friction.
f_2 = Discharge pipe friction.
f_3 = Barometric leg friction.
F = $f_1 + f_2 + f_3$ = total pipe friction.
V = Vapor pressure + 25 per cent = Syphon loss and factor of safety.

Note: Owing to presence of air in the water, in excess of saturation and resulting from entrainment and leakage, the vapor pressure equivalent in feet, corresponding to maximum discharge water temperature, is increased by 25 per cent to compensate for the same. The factor V is usually termed syphon loss and factor of safety and is a justifiable addition to the pumping head.

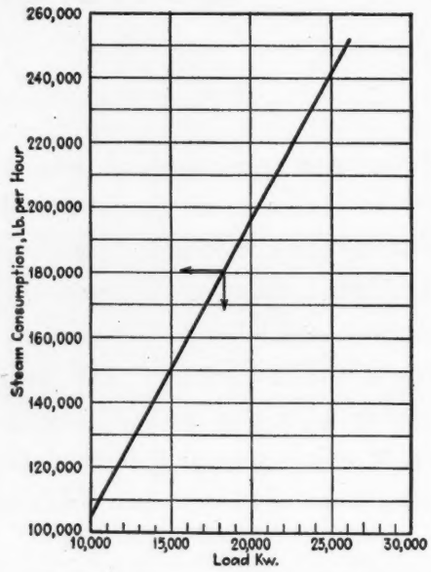


Fig. 2—Williams line for 10,000 to 25,000 kw. load

As an example, assume that a prospective purchaser has made a comprehensive analysis of his power requirements, and the decision to purchase a turbine-generating unit is based on the following anticipated loading:

	Water, Deg. F	—Hours Operation at Kw.—, 10,000	15,000	20,000	25,000	Total Hours	Million Lb. Hr. Deg. F.	Thousand Hr. Deg. F.	Million Lb. Hr.
Jan.	35	100	125	150	200	575	3,735	20.1	106.7
Feb.	37	95	115	135	170	515	3,500	19.05	94.5
Mar.	50	90	105	120	145	460	4,178	23	83.5
Apr.	55	85	95	105	125	410	4,058	22.55	73.8
May	64	80	90	100	110	380	4,349	24.3	67.9
June	73	75	85	90	100	350	4,548	25.55	62.3
July	78	75	85	90	100	350	4,790	27.3	61.4
Aug.	80	75	85	90	100	350	4,985	28	62.4
Sept.	73	80	95	105	115	395	5,171	28.8	70.9
Oct.	52	85	105	120	140	450	4,258	23.4	81.9
Nov.	42	90	115	135	170	510	3,951	21.4	94
Dec.	37	100	125	150	200	575	3,948	21.25	106.7
Totals		1,030	1,225	1,390	1,675	5,320	51,471	284.7	966.0
Water rate, lb. per kw.....		10.54	9.86	9.77	9.69*				
Steam flow, lb.		105,400	148,000	195,300	242,200*				

*Note These water rates and total steam flows are assumed for 28.5 in. vacuum performance, 360 lb. and 250 deg. superheat.

Since the size of condenser is a function of water temperature and weight of steam condensed per hour, the justifiable size is a function of the total kilowatt-hour output per year and therefore total weight of steam condenser per year prorated in terms of steam condensed

per hour at a yearly weighted average water temperature.

Items in the column headed "Million Lb.-hr.-deg. F." are obtained by multiplying together the temperature of the water, the kilowatt load, water rate at 28.5 in. and hours of operation. The water rate is based on the design of the turbine and is assumed to approximate the yearly average vacuum performance of the condenser. This procedure involves a slight error, though it is relative and the tendency is to balance over the year. However, the process eliminates greater possible errors and closely aproaches a true average operating basis for correct determination of condenser size. To simplify the examples used in this article no stage feed-water heating is considered; that is the flow to the throttle is taken as the flow to condenser.

The total value of the foregoing compilation is 51,471,000,000 "lb.-hr.-deg. F." and 284,700 "hr.-deg. F." and 966,000,000 "lb.-hr.," for the yearly period.

$$\text{Therefore, } \frac{51,471,000,000}{284,700} = 180,800 \text{ lb. per hr.,}$$

or the "weighted average" steam to be condensed per hour; also,

$$\frac{51,471,000,000}{96,000,000} = 53.3 \text{ deg. F.,}$$

is the "weighted average" water temperature throughout the year.

By plotting a Willan's line, with total steam flow for the four loads as ordinates and load in kilowatts as abscissa, as Fig. 2, the weighted average load corresponding to a steam flow of 180,800 lb. of steam per hour is 18,300 kilowatts.

Thus with a 25,000-kw. turbine designed for 28.5-in. vacuum performance and operating at a mean average load of 183,000 kw., or a steam flow of 180,800 lb. per hour, during a period of 5,320 hr. per year, the problem of determining the most economical vacuum with 53.3 deg. F. circulating water is presented and the vacuum correction at 18,300 kw., characteristic of this turbine, can be used in the evaluation to follow.

Based on the foregoing method of weighted-average load analysis, the capacity factor is

$$\frac{18,300 \text{ kw.} \times 5,320}{25,000 \text{ kw.} \times 8,760} \times 100 = 44.5 \text{ per cent}$$

3. *Turbine Water Rates at Various Loads and Vacua*—Many purchasers have adopted individual methods of load and economic vacuum analysis; others depend upon the manufacturer. It is for the latter that the foregoing has been covered. With such a load chart as assumed, purchasers of large units have been known to treat each load separately to determine total yearly steam cost, in which event the weighted-average water temperature and steam flow for each load should be obtained, from which the resulting vacua for the assumed cases can be calculated. Thus it is important to know the water rates of the main unit at various loads and vacua in order to make the resulting steam flow corrections. Or, where such information is withheld, a dollar equivalent for vacuum differences should be specified.

4. *Circulating-Water Temperature Chart*—The value of these data has been explained, and in cases where the purchaser is definitely committed to a water temperature basis for design conditions, such a chart may prove valuable in the selection of condensers to follow the initial units.

5. *Maximum Permissible Quantity of Circulating Water*—For various reasons, peculiar to local conditions, such as river capacity, number of units, anticipated ultimate capacity, etc., an economic analysis may show a justifiable quantity of water in excess of that allowable. It is important, therefore, if such limitations are a possibility, to become acquainted with all facts pertaining thereto. A final graph or tabulation of the various assumed cases will indicate the most economical case, qualified as to the limit placed on water quantity.

6. *Required Vacuum Performance*—In most cases the purchaser specifies the required condenser vacuum for a given load or steam flow with circulating water of a given temperature. Under such conditions the problem is reduced to one of determining the most economical water velocity at a given vacuum. But in cases where determination of the most economical vacuum is left to the manufacturer the analysis must cover a range of assumed vacuum conditions in order to find the most economical "surface-g.p.m." ratio of circulating water.

Evaluating Factors

Under this heading are classified actual monetary values for the various elements comprising total yearly operating cost, or equivalent evaluated cost of the installation. These vary according to local costs, operating conditions and method of application. The usual evaluating factors used in an economical analysis are as in the following tabulation which also includes assumed values for the pertinent items used in arriving at a total equivalent investment. The 25,000 kw. unit, previously assumed, will be the basis for analysis to follow[1]:

1. Generating cost of auxiliary power per kwh	$0.0075
2. Hours of operation at weighted-average load	5,320
3. Value of 1 kw. reduced plant capacity required for auxiliaries	$40
4. Capitalization rate for differences in annual cost, per cent	12.5
5. Cost of steam per 1,000 lb., cents	25
6. Improvement in steam consumption for each 0.10 in. increase in vacuum below 29 in. at average load, per cent	3.5
7. Increase in steam consumption for each 0.10 in. decrease in vacuum below 29 in. at average load, per cent	7.5
8. Length of life of condenser tubes, years	5

[1] These figures should in no way be considered as applicable for general use, such values being governed by local conditions. The purpose is to explain one process of calculation.

Determination of Capitalization Constants or Equivalent Investments

Auxiliary Power Costs—Some operating companies charge auxiliary power, not only at the cost of generation, but include a charge for reduced station capacity in the amount of fixed charges on such auxiliary capacity. Thus a unit operating 5,320 hr. a year in a station in which the cost of generation alone is 0.0075 per kilowatt-hour and the fixed charges are 12.5 per cent, the charge for reduced station capacity per kilowatt-hour is $0.0075 \times 0.125 = 0.0009375$, or the equivalent investment of

$$\frac{0.0009375 \times 5,320}{0.125} = \$40 \text{ per kilowatt}$$

It is essential, therefore, in arriving at the cost of a kilowatt-hour to determine whether or not it includes fixed charges. In the above case the components of total value of a kilowatt-hour are:

0.0075 = Cost of generating one kilowatt-hour.

$0.0009375 = Fixed charges, or the value of one kilowatt-hour reduced station capacity.

The total cost chargeable against auxiliary power is 0.0075 + 0.0009375 = $0.0084375 per kilowatt-hour.

Therefore, assuming motor efficiency, line losses, etc., as 85 per cent.

$$\frac{0.0084375 \times 5{,}320 \times 0.746}{0.85} = \$39.377 \text{ per horsepower-year}$$

Item 1. $\frac{39.377}{0.125} = \$315.20$ Capitalized constant per auxiliary horsepower, or equivalent investment per horsepower expended.
Assumed motor efficiency, line losses, etc. 85%

Improvement in Steam Consumption Above 29 In.—Assuming the water rate correction at 18,300 kw., or 180,800 lb. total steam flow per hour, "weighted average" load to be 7.5 per cent per inch between 28 and 29 in. and 3.5 per cent per inch above 29 in., the improvement in steam consumption for each 0.10 in. increase in vacuum above 29 in. will be:

$$\frac{180{,}000 \times 0.035}{10} = 633 \text{ lb. per hour, saving.}$$

$$\frac{633 \times 5{,}320 \times 0.25}{1{,}000} = \$840 \text{ per year per 0.10 inch.}$$

Item 2. $\frac{840}{0.125} = \$6{,}720$ —Capitalized constant, or equivalent investment per 0.10 in. above 29 in. This item represents a saving above 29 inches.

Increase in Steam Consumption Below 29 in. Vacuum—

$$\frac{180{,}800 \times 0.075}{10} = 1{,}355 \text{ lb. per hour, increase.}$$

$$\frac{1{,}355 \times 5{,}320 \times 0.25}{1{,}000} = \$1{,}800 \text{ per year per 0.10 inch.}$$

Item 3. $\frac{1{,}800}{0.125} = \$14{,}400$ — Capitalized constant, or equivalent investment per 0.10 in. below 29 in. This represents an additional cost, or loss referred to 29 in. vacuum performance.

Tube Replacements—The item of condenser tube replacements is also variously treated. The average life of condenser tubes is about 6½ yr. Should local water conditions materially reduce the life of tubes thicker tubes or special metals may be in order. Thus the yearly charge against an installation for tube renewals is approximately 15 per cent of the total initial cost of tubes. This cost evaluated at the prevailing rate set up for capitalization gives the total equivalent investment.

Assume tubes to cost 30c. per pound and to weigh 2.1 lb. per square foot in this case.

$$\frac{0.30 \times 2.1}{5} = \$0.126 \text{ cost per sq.ft. per yr.}$$

Item 4. $\frac{0.126}{0.125} = \$1.01$ — Capitalized constant per square foot of surface, or equivalent investment. This constant is applied directly to the total square foot of surface.

Cost of Steam for Air Ejector—This items applies directly to air ejector steam consumption and is used only when ejectors of different sizes are employed.

$$\frac{0.25}{1{,}000} = 0.00025 \text{ per pound.}$$

$0.0025 \times 5{,}320 = \$1.33$ per pound per year.

Item 5. $\frac{1.33}{0.125} = \$10.65$ — Capitalized constant per pound of steam, or equivalent investment. This constant is applied directly to total normal operating steam consumption of air ejectors.

Cost of Condensate Temperature Depression—If the installation is designed for stage heating, the value of bled steam can be approximated. Assuming that 400 lb. of steam must be added to the throttle for each, 1,000 lb. bled in order to maintain the same load, the approximate cost of such heating steam is 40 per cent of the throttle steam. Thus for a total steam flow to condenser of 180,800 lb., the charge for each degree of condensate depression, assuming 1,000 B.t.u. heat content per pound,

$$\frac{180{,}800 \times 5{,}320 \times 0.25 \times 0.40}{1{,}000 \times 1{,}000} = \$96.20 \text{ per yr. per deg. F. depression.}$$

Item 6. $\frac{96.20}{0.125} = \$770$ — Capitalized constant, or equivalent investment. This constant is applied directly to each degree F. of condensate depression at the "weighted-average" load.

Total Equivalent Investment is equal to

(*a*) Initial apparatus cost less cost of tubes.
(*b*) Plus (Item 1) × (total auxiliary horsepower).
(*c*) Plus Item 5 × (total operating steam consumption of ejector).
(*d*) Plus Item 6 × (degrees condensate depression).
(*e*) Plus Item 3 × (number of 0.10 in. vacuum below 29 inches).
(*f*) Minus Item 2 × (number of 0.10 in vacuum above 29 inches).
(*g*) Plus Item 4 × (total square feet of surface).

Yearly Operating Cost—This item is determined as follows:

Total equivalent investment (Item 7) × capitalization rate.

ECONOMIC ANALYSIS

Basic Data:

Required Factors		*Known Factors*	
Surface, sq.ft.	= S	Lb. steam per hour	— 180,800
Circulating water, Gpm	= G	Inlet water temp	— 53.3 deg. F.
Most economical vacuum		Diameter tubes	— ¾ in.
Most economical water velocity		Thickness tubes	— 18B.W.G.
		Active length of tubes	— 20 ft. 0 in.
		Number of passes	— 2

The 25,000-kw. turbine loading and water temperature previously determined will be the basis for the example to follow.

Tabulation of Results

For convenience and with a view to eliminating errors, a tabulation involving various condenser cases that meet the specified conditions for each of five water velocities, and for a range of vacuum conditions, is determined, it being assumed that the most economical water velocity lies between 4 and 8 ft. per second and that the most economical vacuum lies between 28.7 and 29.1 in., referred to a 30-in. barometer. The results are tabulated as follows:

(*a*) TABULATION OF PHYSICAL FACTORS 28.7 IN. VACUUM

Water Velocity	4	5	6	7	8
G.p.m.	13,520	14,300	15,000	15,650	16,275
Sq.Ft.	20,930	17,740	15,500	13,870	12,600
B.h.p.	46	62	80.7	102	128
	28.8 In. Vacuum				
G.p.m.	14,620	15,450	16,240	16,900	17,580
Sq.Ft.	22,660	19,170	16,770	14,970	13,620
B.h.p.	49.8	67	87.3	110	138
	28.9 in. Vacuum				
G.p.m.	16,050	16,970	17,800	18,570	19,300
Sq.Ft.	24,900	21,050	18,380	16,450	14,950
B.h.p.	54.5	73.7	95.7	121	151.5
	29.0 In. Vacuum				
G.p.m.	17,780	18,780	19,730	20,550	21,400
Sq.Ft.	27,550	23,270	20,350	18,210	16,580
B.h.p.	60.5	81.5	106	134	168
	29.1 In. Vacuum				
G.p.m.	20,300	21,480	22,530	23,500	24,400
Sq.Ft.	31,480	26,660	23,280	20,800	18,900
B.h.p.	68.2	93.2	121	153.3	191.5

(b) TABULATION OF EVALUATION FACTORS

	Velocity	4	5	6	7	8
28.7	Cost d&e (less					
in.	tube cost)	59,960	53,040	48,435	44,830	42,250
vacuum	Power investment	14,500	19,500	25,400	32,100	40,350
	Charge below 29 in.	43,200	43,200	43,200	43,200	43,200
	Charge tube life	21,125	17,925	15,650	14,000	12,725
	Total equiv. invest	138,785	133,665	132,685	134,130	138,525
28.8	Cost	63,900	56,660	51,610	47,625	44,850
in.	Power charge	15,700	21,100	27,500	34,700	43,500
vacuum	Below 29 in., charge	28,800	28,800	28,800	28,800	28,800
	Tube life, charge	22,900	19,370	16,950	15,130	13,760
	Total equiv. invest.	131,300	125,930	124,860	126,255	130,910
28.9	Cost	69,335	61,370	55,675	51,595	48,505
in.	Power charge	17,200	23,200	30,200	38,100	47,700
vacuum	Below 29 in., charge	14,400	14,400	14,400	14,400	14,400
	Tube life, charge	25,150	21,275	18,560	16,620	15,100
	Total equiv. invest.	126,085	120,245	118,835	120,715	125,705
29.0	Cost	75,680	66,965	60,485	55,915	52,700
n.	Power charge	19,050	25,650	33,400	42,200	53,000
vacuum	Tube life, charge	27,900	23,550	20,600	18,400	16,750
	Total equiv. invest.	122,630	116,165	114,485	116,515	122,450
29.1	Cost	85,700	74,900	67,895	62,595	58,635
in.	Power charge	21,450	29,400	38,100	48,250	60,300
vacuum	Above 29 in., credit	*6,720	*6,720	*6,720	*6,720	*6,720
	Tube life, charge	31,800	26,950	23,520	21,000	19,100
	Total equiv. invest.	132,230	124,530	122,795	125,125	131,315

*Credit.

Note: Condensate pump, power and ejector steam consumption are not tabulated, since they are constant for all cases. Condensate depression assumed as 0 deg. F. involves no charge.

Analysis of Curves

Fig. 3 indicates in curve form the foregoing tabulations, as follows:

1. Curves *A* are plotted with velocity as abscissa and total equivalent investment as ordinates, and for each vacuum indicate a velocity of 5.9 ft. per second as the "most economical velocity."

2. Curve *B*. With the foregoing equivalent investment for the respective vacua, the former again plotted as ordinates and the latter as abscissa, the resulting curve indicates the "most economical vacuum" at 28.99 inches.

3. Curves *C* are obtained by plotting velocity as abscissa and the corresponding surface for each vacuum condition as ordinates, so that a projection of the economical velocity line (5.9 ft. per sec.) through each curve *C* indicates the economical surface in each case.

4. Curve *D* is obtained by plotting the economical surface as ordinates and the corresponding vacuum as abscissa, thus giving an economical surface line for various vacua at the velocity of 5.9 ft. per sec. Projecting the economical vacuum line (28.99 in.) through curve *D*, indicates a surface of 24,400 sq.ft. as the "most economical surface."

5. Curves *E* are gallons-per-minute lines for the various vacuum conditions and plotted in the same manner as the surface lines *C*.

6. Curve *F*. From curves *E*, the gallons-per-minute curve at 5.9 ft., velocity is plotted in the same manner as the surface line *D*. The "most economical gallon-per-minute" is indicated as 19,400 at a vacuum of 28.99 inches.

Suggested Specifications

In the event of the manufacturer being required to determine the most economical vacuum, and assuming that the purchaser specifies at least the tube size, gage

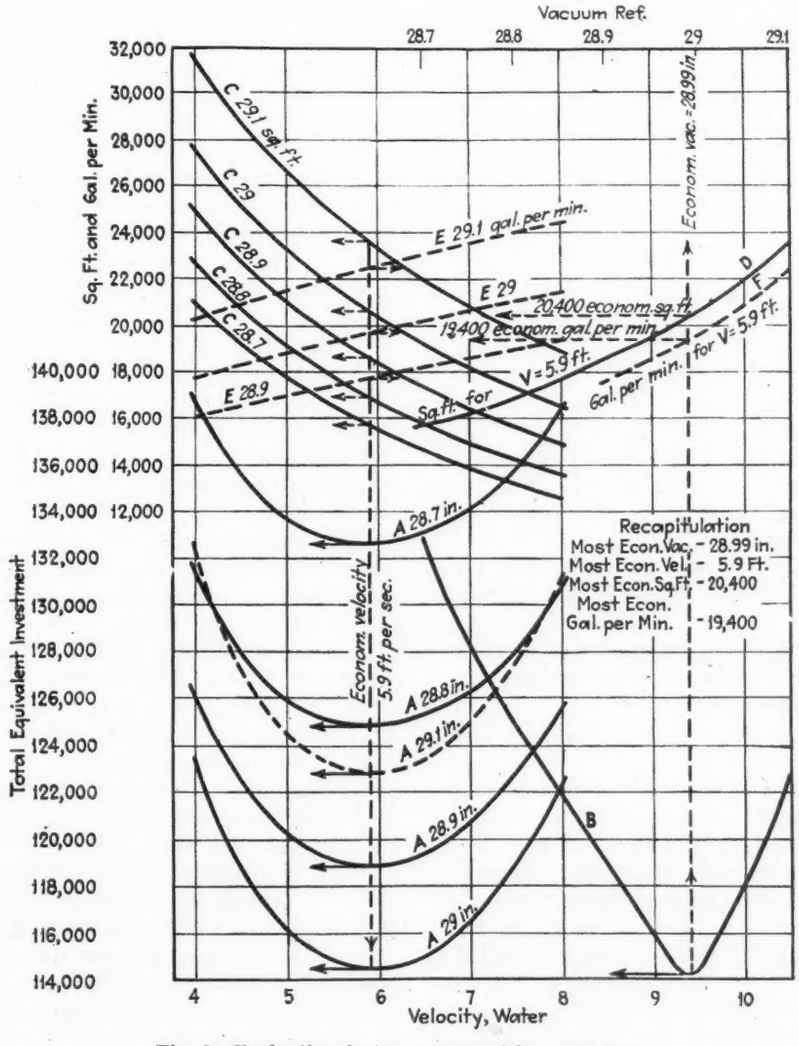


Fig. 3—Evaluating factors expressed in curve form

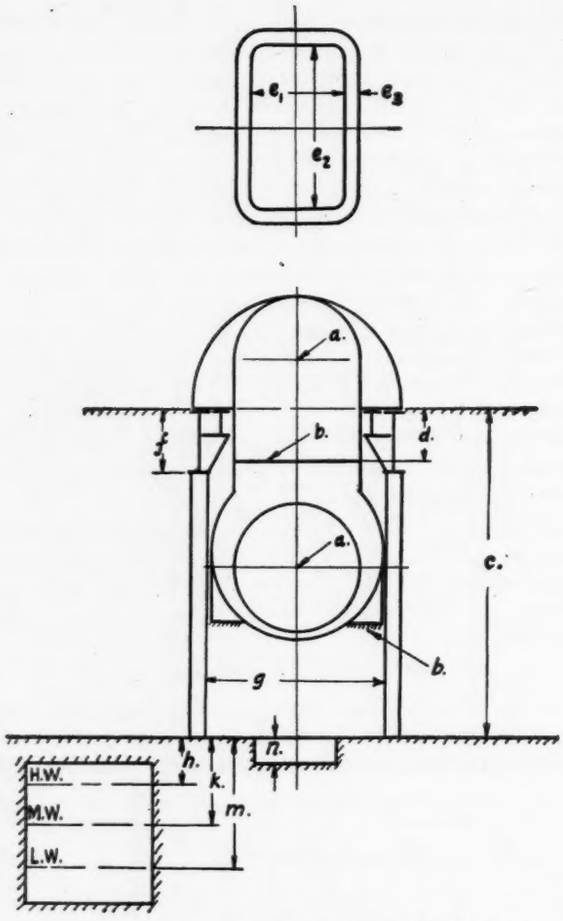


Fig. 4—Showing limits of condenser installation

and length, it is important that the specifications include the following information.

A—Condenser

1. Number of passes.
2. Type of waterbox, divided or non-divided and number of water connections.
3. Tubes.
   (*a*) Furnished by.
   (*b*) Installed by.
   (*c*) Outside diameter.
   (*d*) Thickness of wall.
   (*e*) Active length.
   (*f*) Method of tube fastening.
   (*g*) Packing furnished by.
4. Limits of condenser installation. (See Fig. 4).
   (*a*) Position of condenser axis relative to turbine axis.
   (*b*) Method of supporting condenser and kind of connection to turbine exhaust flange.
   (*c*) Floor to floor dimension.
   (*d*) Distance from turbine floor to face of turbine exhaust flange.
   (*e*) Dimensions of turbine exhaust opening and width of flange.
   (*f*) Depth of turbine supporting structure.
   (*g*) Distance between main supporting columns.
   (*h*) Distance condensate pump pit below floor.

B—Circulating Pumps

1. Number required and if more than one should they be duplicates.
2. Physical features.
   (*a*) Side or bottom suction.
   (*b*) Horizontal or vertical type.
   (*c*) Kind of drive and its power characteristics, steam or electrical. If steam, state pressure, superheat and back pressure; if electrical, state characteristics of current.
   (*d*) Separate or continuous soleplate.
3. Pumping head exclusive of condenser friction.
   (*a*) Difference of water levels in intake and discharge tunnels.
   (*b*) Pipe friction for a given quantity of water.
   (*c*) Syphon loss and factor of safety.
   Note: The above is on the basis of a sealed system; otherwise, the static head should be specified.
   (*d*) Elevations of water levels. (See Fig. 4).
   a. Distance high water below floor (or above).
   b. Distance mean water below floor (or above).
   c. Distance low water below floor (or above).

C—Condensate Pumps

1. Number required.
2. Physical features.
3. Capacity.
4. Pumping head including 34 ft. condenser vacuum.
5. Minimum allowable submergence.
   (*a*) Single- or multi-stage.
   (*b*) Design of casing and desired location of water connections.
   (*c*) Kind of drive and its power characteristics.
   (*d*) Separate or continuous soleplate.

D—Air Ejector

1. Number of units required for normal operation. (Specify spares if required and arrangement.)
2. Coaling medium.
   (*a*) Raw water.
   (*b*) Condensate.
   (*c*) Raw water and condensate.
3. Capacity of each unit in pounds per hour at specified vacuum.
4. Available steam pressure and its characteristics, together with likely minimum pressure.

E—Accessories

1. Expansion joint.
2. Spring supports.
3. Relief valve.
4. Exhaust connection.

F—Evaluating Factors

1. Weighted-average steam flow to condenser per hour.
2. Weighted-average water temperature for year.
3. Hours of operation per year.
4. Total cost of auxiliary power
   (*a*) Cents per kw.-hr. if motor driven.
   (*b*) Steam cost per 1,000 lb. if turbine driven.
   Note: If drive is furnished by purchaser, horsepower rating and meter efficiency or turbine water rate should be specified.
5. Capitalization rate.
6. Maximum allowable quantity of circulating water if there is a limit.
7. In case the most economical vacuum is left to the manufacturer, the following data is required.
   (*a*) Turbine water rate at various vacua at the average load; or in terms of per cent increase or decrease for variations of 0.10 in. of condenser vacuum referred to definite vacuum.
8. Evaluated cost of steam used by the turbine per 1,000 pounds.

Selecting Size of Raw-Water Orifice for a Softener

By R. F. HOLLIS

THE CHEMICAL PROPORTIONER of a hot-process water softener is controlled from a differential pressure created by an orifice in the raw water line. The proportioner is designed to feed the chemical solution to the sedimentation tank in direct proportion to the flow of raw water. However, it only operates satisfactorily within certain limits of differential pressure. If the load on the softener changes so that the differential pressure is varied above or below the maximum or minimum limits of the proportioner, the latter

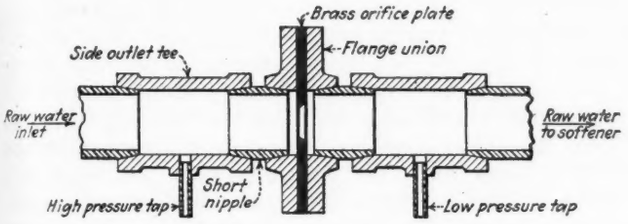


Fig. 1—Detail of conventional raw-water orifice

will not feed the chemical solution in the proper ratio to the amount of raw water flowing to the softener. It then becomes necessary to change the size of the orifice to bring the differential pressure within the best working range of the proportioner. Of course a change in the size of the raw-water orifice will require other adjustments, which may include the varying of the strength of the chemical solution or changing the size of the chemical orifice ferrule.

The raw-water orifice may better serve if its primary function of controlling the proportioner be extended to the additional service of being a flow-meter element. It is of great help to the operator to install some means of observing the differential pressure across the raw-water orifice so that a close estimate of the instantaneous load on the softener may be made.

Fig. 1 shows details of the conventional raw-water orifice installation for a hot-process water softener. The differential pressure may be observed by altitude gages on each of the two pressure lines, a mercury manometer, or a recording differential pressure gage. The latter will provide a record of the differential pressure which may, in turn, be translated into rate-of-flow values by calculation. The average rate of flow may be determined for a time period from the differential pressure gage chart with a square-root radial planimeter to obtain the true average differential pressure.

The instruction book furnished to the operators of this particular softener presents in tabular form the rates of flow of raw water through the various sized orifices with various differential pressures. Knowing the maximum and minimum limits of the differential pressure for the best working range of the proportioner, reference to the flow table will indicate which size of orifice is most suitable for the particular range of raw-water flow. Fig. 2 illustrates a series of differential pressure rate-of-flow curves which serve better to indicate the proper selection of the raw-water orifice size. This particular series of curves as arranged for a 5,000-gal. per hour softener, and the flow units are in pounds of water per hour for convenience in referring to the rate of feed-water flow to the boilers as observed from a venturi meter.

The best working range for the proportioner of this softener was found to be a differential pressure of from 4 to 16 ft. of water. The utility of this series of curves is obvious. Suppose it is observed that the differential pressure is varying between 10 and 25 ft. with a $\frac{7}{8}$-in. orifice. The corresponding rate of flow is 14,700 to 23,400 lb. per hour, and dropping vertically on these flow lines, it is noted that the 1-in. orifice will give a corresponding range of 6 to 15 ft. of water differential pressure, which is within the best working range of the proportioner. Also, an auxiliary scale indicates the load on the softener in per cent of its rated capacity.

Again referring to Fig. 1, it will be evident that the pressure taps are not properly located to indicate the true differential pressure between the upstream section of flow and the vena contracta of the orifice jet. Also, the presence of the pipe nipples results in some head loss from abrupt contraction and enlargement of the water stream. But practice has indicated that the differential pressure created by this orifice assembly controls the proportioner within its best working range in a satisfactory manner. Because of these conditions, the tabular values presented in the instruction book, and the graphical values indicated by the curves, Fig. 2, were based on relations existing in orifices having free discharge, and also considering the coefficient of discharge to be a constant for all cases. If the raw-water orifice installation be modified so that the short nipples and tees could be replaced by a continuous smooth pipe, and the pressure taps be arranged one pipe diameter upstream and one-half pipe diameter downstream of the orifice, the

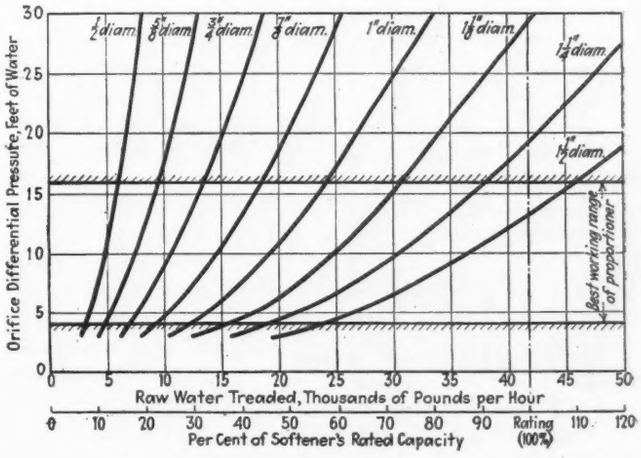


Fig. 2—Differential pressure rate-of-flow curves

assembly would be comparable to those on which much research has been made.

In any case, where the operator is now referring to the tabular values presented in the instruction book, a series of curves similar to those in Fig. 2 may be substituted to gain a marked increase in the operating efficiency of the water softener, because the operator may better visualize the load conditions and select more easily the proper size of raw-water orifice.

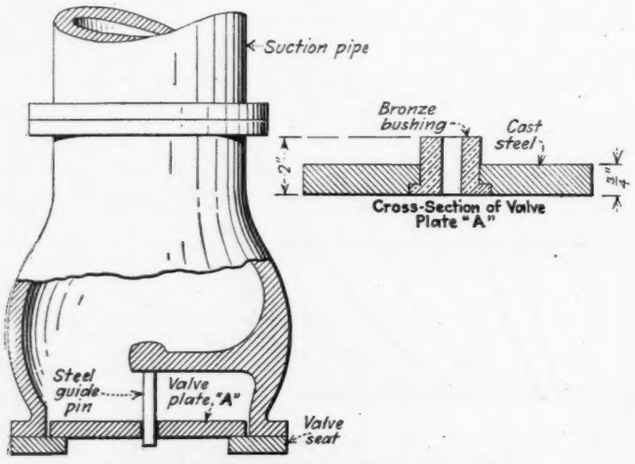
PRACTICAL AIDS TO OPERATION

Bronze Bushing Improves Operation of Foot Valve

A 2,000-G.P.M. centrifugal pump which furnished water for a large mining operation gave trouble from losing its prime whenever the power went off or a temporary shutdown occurred. The trouble was supposedly due to a leaky foot valve. But as the valve was under from 3 to 6 ft. of water it was difficult to tell just what caused the trouble.

Being in the pump room one day when the power went off, I noticed that the pump stopped immediately and suddenly reversed its direction of rotation. As it gathered momentum I rushed to the shutoff valve and hurriedly closed it, but the pump had reached considerable speed before the valve was completely closed. In this instance it was evident that the foot valve had failed. The valve also at times would hang open and then close violently, causing considerable water-hammer.

Upon examining the valve we found that it would hang open because the guide did not have sufficient length, and side play would cause uneven thrust on the pin support. To overcome this trouble we fitted a bronze guide



Bronze bushing fitted to disk prevented its sticking open

bushing in the plate as shown in the detail. The bushing was made as long as possible without restricting the flow through the valve. When the valve was again in place we made several tests to satisfy ourselves that it would operate properly. When water had been picked up, the motor was shut down and the valve closed almost immediately. We were not content until this result had been achieved after several consecutive startings. This foot valve was repaired several years ago and is still working perfectly. G. H. EMERSON.

Birmingham, Ala.

Troubles From Improper Grounding of Electrical Equipment

NOT INFREQUENTLY all the results of an accident to electrical machinery will not show up at the time of the accident, but sooner or later other things will develop which can be traced to the former trouble. An experience we had some time ago proved that it is advisable to trace out all trouble at the time of occurrence.

A horizontal alternating-current generator was connected to a set of waterwheels and was arranged to run in parallel with other generators in the station as well as with other stations on the system. The frame of the generator had been grounded by means of clamps attached to the frame of the generator and to the lead sheath of the cable carrying the main feed wires to the switchboard. Some time later the main cable burned off and single wires were installed in the place of the lead-covered cable, leaving the generator without any ground connection, the ground being overlooked in this case. After about two months the following took place.

The station operators detected an odor of burned oil. After considerable investigation it was traced to the generator which had given trouble a short time before by the cable burning off. The bearings were not noticeably warm, but the odor persisted and a sizzling was heard. Upon removing the small caps from the bearings above the oil rings a flashing was seen to exist between the oil ring and the shaft, evidently due to a current coming from some part of the windings of the machine and following the path of least resistance to ground.

To see just what was going on, a stick was procured and the ring pushed over enough toward the middle of the oil way so it would not hit the side of the bearing. Then the flashing stopped.

Upon stopping the machine and testing, one phase of the windings was found grounded to the frame. This accounted for the current jumping from the oil rings, as they rubbed the side of the bearing, to the shaft, which gave it a good path to the ground. After the grounded coil was replaced the ground cleared up.

The generator was started as previously, that is, without any ground wire from the frame, it not being given any thought at the time. The generator ran for less than a week when an odor of hot oil and babbitt was noticed, and on investigation it was found that one of the main bearings was abnormally warm. The generator was stopped and the top half of the bearing was removed. It seemed to be in fair shape except that considerable babbitt had been roughed off the lower shell and had come to the top as the shaft rotated. When the bottom shell was removed it was found in rather bad condition; the oil ways had filled up, stopping the flow of oil, and it had to be rebabbitted.

After getting the generator back in service, a thorough investigation was made, and the following conclusion arrived at. When the coil had grounded to the frame, current had followed the frame to the bearing, and as the oil ring had rubbed the side of the bearing it had picked up the current, which flashed to the shaft, passed along the shaft to the waterwheels and into the ground. The flashing between the ring and the shaft had caused the oil, which was carried to the top of bearing, to become oxidized, thus lessening its lubricating qualities, so much so that the bottom shell did not get sufficient oil, causing the oil ways to fill up.

After the foregoing solution had been arrived at a

ground wire was connected from the frame of the generator to the next machine, which had a good ground to the waterwheels, as well as to a permanent ground outside the plant. Since attaching the ground wire no further trouble has been experienced.

Brunswick, Me. LEON L. POLLARD.

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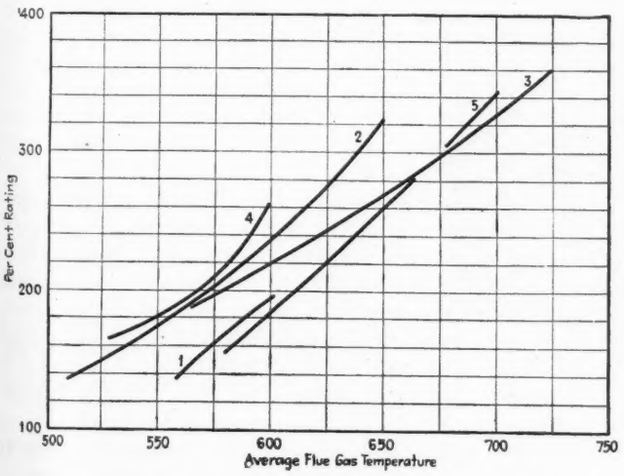
CURRENT COMMENT

Flue-Gas Temperatures From Boiler Rating

IN THE March 1 number of *Power* J. R. Darnell gave two curves, *A* concave downward and *B* concave upward, plotting as the abscissa, the flue gas temperature and as the ordinate, the per cent of boiler rating. He stated that there is some disagreement as to whether the temperature and rating vary as in curve *A* or *B*, but that he favors curve *A*. The accompanying chart shows the same curves for five boilers, varying in size from 6,300 to 60,000 sq.ft. of water-heating surface, which may be taken as representative since they were manufactured by three different concerns.

It will be seen that curve 1 is slightly concave downward, agreeing with curve *A* of Mr. Darnell, but that the curves 2 to 5 are concave upward. This shows from actual test data that the curve may be either way.

The flue gas temperature varies considerably at any given rating for different boilers, due to different



Gas temperature per cent rating curves for five boilers varying in size from 6,300 to 60,000 sq.ft.

designs, such as arrangement of baffles and amount of heating surface exposed to direct radiation. Considering a given boiler, the flue gas temperature may change at a given rating due to a change in excess air, fuel composition or cleanliness of tubes.

Hence, it seems to me, that no curve showing relation of gas temperature to per cent of rating can be given for boilers in general.

Astoria, N. Y. GORDON R. HAHN.

Methods of Deaërating Boiler-Feed Water

I NOTED with interest a comparison of investment charges for the installation of a deaërating heater in place of a single extraction bleeder heater in an article entitled "Methods of Deaërating Boiler-Feed Water" in the March 22d number of *Power*.

To make the two feed-water heating systems analagous from the standpoint of thermal efficiency, the original article assumes the installation of a surface bleeder heater designed to give the same outlet temperature as the type of deaërator with which it is compared. In explanation of the operation of a deaërator it is stated that "this heater (the deaërating open heater) is fed with bled steam from the main turbine and the temperature of the condensate is raised sufficiently to cause it to flash in the heater, thus relieving itself of dissolved oxygen."

Deaërators of the type described are frequently designed to give an outlet water temperature of 20 to 25 deg. below the saturation temperature of the steam obtained from the exhaust header or turbine bleed line used for feed-water heating, and are therefore less desirable from the standpoint of thermal efficiency than an ordinary extraction bleeder heater operating with 5- or 10-deg. terminal difference, or the direct-contact heater operating with a terminal difference of 2 to 5 degrees.

However, it is not my intention to create the impression that the use of an open deaërator creates a penalty of thermal disadvantage but rather that direct-contact deaërators are obtainable which deliver water to the boiler-feed pumps at less than 1 deg. below the saturation temperature of the steam supplied for feed heating, therefore combining a distinct thermal advantage over some types of feed-water heaters or deaërators with the advantage of protection from oxygen corrosion. Deaërators of the type referred to supply oxygen-free water without resort to the flashing process and therefore do not carry the thermal handicap of the latter type.

It is therefore apparent that from the standpoint of thermal efficiency and in order of preference the four methods of heating feed water by bled or exhaust steam are as follows:

1. Direct contact deaërator supplying oxygen-free water at full saturation temperature of steam supply.
2. Common direct-contact type feed-water heater giving partial oxygen elimination and operating with a terminal difference of 2 to 5 deg. F.
3. Surface type bleeder heater operating with a terminal difference of 5 to 10 deg. F.
4. Flash type deaërator supplying boiler feed water at a temperature approximately 20 deg. F. below the saturation temperature of bled or exhaust steam furnished for feed-water heating.

If, in the analysis contained in the article referred to, it is assumed that the extraction bleeder heater has the same terminal difference as the flash-type deaërator, or about 20 deg., an appreciable thermal saving might be made by installation of a deaërator operating with a zero terminal difference. The saving thus made may be quickly evaluated in the following manner:

Determine the heat content of the steam supplied at the turbine throttle, at the extraction point and at the condenser. For a unit of the size outlined (200,000 lb. per hour) for the purpose of example, we shall assume an initial heat content of 1,340 B.t.u. per pound at a 30-lb. abs. bleed point and 1,025 B.t.u. per pound at the condenser operating at 28 in. vacuum.

Approximate the amount of condensate to be received from the condenser. For a deaërator of 200,000 lb. per hour capacity we may assume 175,000 lb. of condensate per hour.

Determine the amount of steam bled from the 30-lb. abs. extraction point to heat the condensate to within 20 deg. of full steam temperature when using a closed heater comparable to a flash deaërator and to full steam temperature when using a direct-contact deaërator without terminal difference. Assuming 100 deg. as the temperature of the condensate from the condenser hotwell, the amount of bled steam required to heat 175,000 lb. per hour from 100 deg. to 230 deg. (20 deg. less than saturation temperature) will be the product of the quantity of condensate to be heated and the change in heat content per pound divided by the total heat of the bled steam at the extraction point minus the heat of the liquid corresponding to the saturation temperature of the extraction pressure or 23,600 lb. per hour. Similarly, the amount of bled steam required to heat 175,000 lb. of condensate to full steam temperature will be 27,200 lb. per hour, a difference of 3,600 lb. per hour in favor of the deaërating heater operating without terminal difference.

Determine the power generated in the turbine by the additional bled steam required by the deaërator operating without terminal difference. The change in heat content of the steam between the throttle and the bleed point indicates the amount of heat converted into useful work. In the example cited this change of heat content is 158 B.t.u. per pound. Therefore, additional bleeding of 3,600 lb. per hour will generate 166 additional shaft-kilowatts. This power is generated without condenser loss; therefore the additional heat required to be added to the boiler is merely the heat equivalent of the additional power generated, the product of 166 kilowatts, and 3,413, a constant representing the number of B.t.u. contained in one kilowatt-hour. Since each shaft-kilowatt generated by the assumed conditions using a bleeder heater with 20 deg. terminal difference or a flash-type deaërator with 20 deg. terminal difference would require 13,130 B.t.u. per shaft-kilowatt, generation of 166 additional kilowatt-hours at 3,413 B.t.u. per kilowatt-hour represents a net saving of 123 kw.-hr. That is to say, the additional heat required to generate 166 kw.-hr. by additional bleeding would generate but 43 kw.-hr. if used to generate additional power when using the bleeder heater or flash deaërator with 20 deg. terminal difference.

Valued at one cent per kilowatt-hour, 123 kw.-hr. is worth $10,750 per year, a figure well worth bearing in mind when selecting the type of deaërating heater to be used.

A. E. KITTREDGE.

Haddon Heights, N. J.

Air Heater Corrosion; Another British Engineer's Views

WE HAVE READ with interest the remarks of B. M. Thornton of Newcastle, England, on the subject of "Air Heater Corrosion" in the March 8 number, in which he comments on the previous article by Louis C. Whiton, Jr., entitled "Practical Comments on the Maintenance of Air Heaters" in the Dec. 28, 1931, number. While we agree with both writers in their diagnosis of the causes of the majority of air heater troubles, we do not concur with certain views expressed by Mr. Thornton.

He states that recirculation of a proportion of the preheated air is inefficient practice because in addition to the increased fan power necessitated the efficiency of the heater is lowered.

We agree that an additional burden is imposed on the forced-draft fan by recirculation, but this can be minimized to a great extent if the air intake is arranged above the boilers, so that a supply of comparatively warm air is available. By this means practically the whole of the radiation losses from the unit may be reclaimed and the amount of air which it is necessary to recirculate is thus reduced to a minimum.

We cannot agree with the statement that recirculation lowers the efficiency of the air heater, because we have repeatedly found in practice that there is no measurable difference in the temperature of either the preheated air or the leaving gases brought about by cutting off recirculation, even when this changes the temperature of the air entering the heater by as much as 60 deg. F. This can be explained by the fact that the decrease in the mean temperature difference between the air and gases resulting from the increase of the entering air temperature is offset by the increased rate of flow of air through the heater.

Over a period of operation, recirculation brings about a considerable increase in efficiency due to the greater cleanliness of the heating surface resulting from the elimination of moisture formation, and also effectively prevents any deterioration of the heating elements. We have found that the heat expenditure equivalent to the increased power consumption of the forced-draft fan resulting from recirculation is small compared with the additional amount of heat which the heater is able to reclaim by virtue of its improved condition.

The suggestion of parallel flow of air heaters instead of the conventional contra-flow, as a means of maintaining the plate temperature, is quite impracticable in the majority of cases. Not only, as Mr. Thornton remarks, is there a loss in efficiency due to a reduced temperature difference, but the system is handicapped by the fact that the final gas temperature must always be above the temperature of the preheated air in order to maintain a temperature difference.

In modern British practice, where a final gas temperature of 250 deg. F. is demanded, it would be difficult to raise the air temperature to a figure much higher than 200 deg. F., and even then an enormous heater would be necessary. The corresponding reduction in gas temperature that would be brought about under such conditions would therefore be limited to about 100 deg. F., which would seriously restrict the field of air heater application.

The operating conditions of the convection steam superheater are not comparable to those of the air heater, as Mr. Thornton suggests. In the case of the superheater the final temperature attained by the steam is several hundred degrees lower than the lowest temperature of the gases in the superheater zone, but in the case of the air heater the final air temperature required is often considerably above the desired temperature of the leaving gases, and therefore, if an air heater is to remain an efficient means of reducing the final gas temperature, the contra-flow system is imperative.

E. W. ROBEY,
Chief Engineer,
Underfeed Stoker Co., Ltd.

London, England.

Straightening a Large Generator Shaft And Aligning Bearings*

How a hydro-electric generator shaft, 30 in. in diameter, was straightened when in a vertical position. The method used for aligning bearings on vertical hydro-electric units so as to bring the bearings in line, but not necessarily a plumb line

By A. S. ROBERTSON

WHILE operating at full load the upper guide bearing failed on one of the Queenston plant generators and before the unit could be shut down serious mechanical damage was done to parts of the generator. The bearing, having wiped on one side, permitted the shaft to swing and rub against the stationary oil catcher, located immediately below the upper guide bearing. This rubbing produced local heating on the shaft which in turn caused it to bend.

In addition to damaging the thrust collar, exciter deck and oil catcher, this rubbing left the shaft with a permanent bend of 0.022 in. in a length of 36 ft., about 18 in. from the top of the rotor. It is interesting that the clearance between the exciter deck and the trust collar, about 6 ft. above the bearing, is approximately $\frac{1}{8}$ in., yet the top of the shaft during the rubbing period bent sufficiently to strike the deck.

The repairs to the deck and thrust collar were easily made, by using the welding machine on the former and shrinking a collar on the damaged section of the thrust nut. However, the straightening of the 30-in. shaft, which with its rotor and field pole assembly, weighing 320 tons, was more difficult. The generally accepted method is to turn the rotor on its side and support the shaft in a horizontal position between two temporary bearings. Turning the rotor assembled was impossible with the plant's crane capacity. After considerable discussion as to the best method and after it was decided that the only reason for turning the shaft was for measurement purposes, it was decided to try and straighten the shaft in its vertical position.

*Paper presented before the Toronto section of the American Institute of Electrical Engineers and published by the Hydro-Electric Power Commission of Ontario in *The Bulletin*. The author is operating superintendent of the Queenston generating station, Hydro-Electric Power Commission of Ontario.

Fig. 1—Straightening the generator shaft by local heating

From previous experience, it was felt that we could check the shaft with sufficient accuracy to insure success in this position. Two boards were mounted on the top of the shaft to form four arms 90 deg. apart, from which was hung four piano wire plumb lines. These arms kept the four plumb lines at a definite distance from the surface of the shaft and also permitted them to pass through holes in the rotor to the coupling on the bottom of the shaft. By means of a micrometer pin gage, readings were taken between the plumb lines and the surface of the shaft at sufficient intervals along its length to determine properly the variation in the shaft from a straight line.

To insure greater accuracy in taking these readings, the pin gage was fitted with a telephone receiver and a dry cell so that every time an electrical contact was made with the gage and the piano wire a click would be heard in the receiver. This insured maximum pressure on the plumb line by the pin gage, so that it could touch the line but not disturb it. An experienced reader can easily obtain results to within a variation of plus or minus 0.002 inch.

This method of measurement had the further advantage that it was not necessary to plumb the shaft and rotor assembly before taking the readings. The plumb lines were hung and the slope per foot determined, after which

the readings were taken in the usual way and corrected for the slope to give the true reading.

Having determined the location of the bend in the shaft and the amount, the next step was to straighten it. The method of straightening consisted of heating the shaft on the outside of the bend which, when it cooled, set up a shrinkage stress sufficient to pull the shaft back into line. To do this satisfactorily it was essential to apply as large a volume of heat and in as short a time as possible. This was to create local heating and to prevent the heat being conducted around the shaft to the other side. After heating, the shaft was left to cool naturally for about 24 hours.

The success of this method of straightening shafts is based on the theory that the application of a localized heat softens and upsets the metal at the point of application. Due to the localized upsetting there is less resistance to shrinkage strains and hence the shaft shrinks the most at this point, which causes it to retract further than its outward movement due to the applied heat.

The set-up for straightening the shaft, Fig. 1, consisted of two large coal-oil burners which were equipped with a 2-in. nozzle on the torches. A baffle consisting of a couple of building tiles and some asbestos paper were used at the shaft to localize the flame. A careful procedure for handling the torches had to be worked out, as the working space was confined and the torches threw an exceedingly hot flame. Each operator of the torch had a definite understanding of how he was to swing the torch to the shaft, after he had started it in the bucket.

The duration of the heat and the amount of deflection required to correct a given bend is largely guesswork and one or more attempts usually are necessary before getting the required results. From the experience of other organizations we were advised that after three heats on the one spot little would be gained and it is better to move to another spot above or below the previous place. The greatest deflection will be from the first heat and each successive application on this spot produces less result.

In this case our objective was obtained in two heats. The first application of heat was made for 10 min., which, while being applied, caused the top of the shaft to move about $\frac{1}{8}$ in. further in the wrong direction. Upon checking the next day it was found that the bend had been reduced by 0.004 in.

When 24 hr. had elapsed from the first application of the torches a second was made, lasting 15 min. At the end of that period the top of the shaft had moved $\frac{1}{8}$ in., as determined from the plumb lines measured at the coupling, in the wrong direction. After a further cooling period of 24 hr. the shaft was checked and found to be within 0.007 in. at the top and 0.0025 in. at the bottom, that is, in a distance of 35 ft. 7 in., and was considered satisfactory for practical purposes.

From this experience it may be said that had the first application been for 15 min. we should probably have secured the desired results in one heat. Further, it will be seen that the biggest problem is in the measurement of the shaft to determine its straightness, and when this is solved the job becomes relatively simple.

Each time a generator unit in the Queenston station, or in any other plant of the Hydro-Electric Power Commission of Ontario, is dismantled for a major repair, its alignment is checked. These units, turbine and generator, consist of two guide bearings on the generator and one guide bearing on the turbine. To check the alignment of these three bearings requires a 45-ft. steel piano wire with a 50-lb. plumb bob suspended on the end of the line. The plumb bob is also placed inside a large pot filled with oil to act as a damper. There are so many disturbances about a power house that it is necessary to use such a heavy plumb bob and an oil pot to damp out the sympathetic oscillations of the line.

This line is centralized in the upper generator bearing and dropped through the other two bearings. The readings are taken with a micrometer pin gage using the same method of taking readings as described in measuring the shaft for straightness. The readings so obtained are corrected for slope and plotted in a chart as in Fig. 2. The chart shows the plotted results obtained from checking the alignment of the three bearings on one unit. Broken lines indicate the alignment as it was found, and the other lines show alignment as it was left after making the necessary alterations.

The second step in correcting the machine's alignment is to bring all three bearings into a common line, but not necessarily a plumb line. When these units were originally installed all three bearings were lined up to a plumb line. Today, after, in some cases, two corrections, the general conditions of all units are as shown on the chart. All three bearings have been brought into a common line, which has an inclination from true plumb. It might be asked why we do not plumb the unit when making corrections. To answer this it is necessary to consider the assembly of the unit and the relation of the various parts.

Starting at the bottom, the scroll case controls the location of the lower guide bearing. This scroll case, being embedded in concrete, does not permit any changes in location. The lower generator guide bearing is assembled in the lower bracket which rests on the base ring. In consequence of this construction, it permits of a vertical movement by shimming of the bracket, and movement of the bracket horizontally about the centerline. The upper bracket rests on the generator frame and has a spigot fit which prevents horizontal movement but it does permit vertical movement by shimming. The generator stator is bolted and doweled to the base ring and permits a vertical movement by shimming and horizontal movement by removing the dowels.

These are the only practical means of correcting the alignment to take care of settlement, but each has its limits of use. Any correction by shimming the stator and moving it about the vertical center requires lifting of 300 tons to place the shims and the redoweling of the frame in a new position. These dowels are 3½ in. in diameter and involve a good deal of work to fit; the lifting of the heavy stator is likewise a serious task. Further, the commercial size of the shimming material places a limit on the correction possible by this method, as it may be too thick and in consequence overcompensate the alignment.

It is because of these difficulties that the correction is usually made at the brackets, and, in consequence, the correction results in an inclined line with respect to the plumb line. Unless a

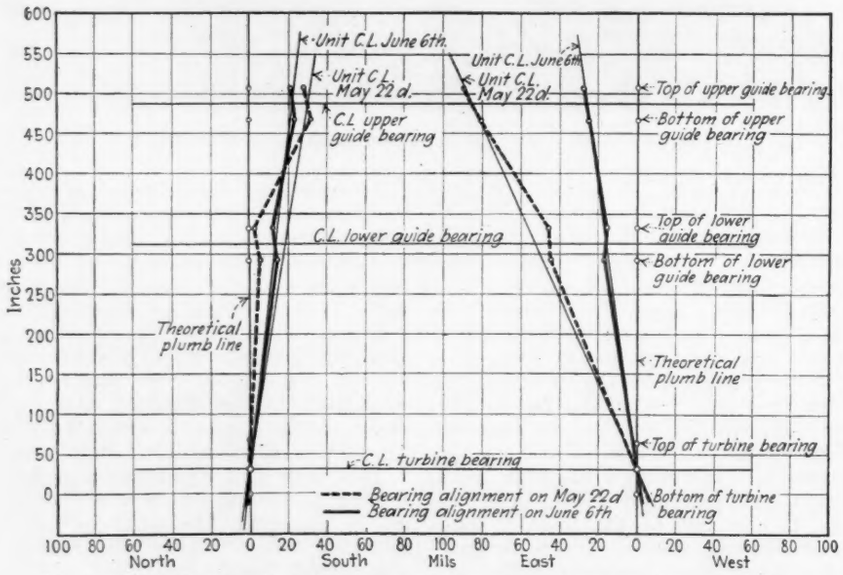


Fig. 2—Chart showing shaft alignment before and after overhauling the machine

proper study is made of the required corrections by plotting the observation as shown on the chart, a much greater inclination will be produced than is necessary. If raising the low side is all done on the one side on both brackets, the center line of the bearing moves about an arc equal to a radius of half the diameter of the brackets. This means that the alignment of the two bearings is on a new line which has a different inclination than the one assumed by the unit in the first place. From a study of this chart it is obvious that if it is desired to maintain the same inclination, each bracket must move in a plane whose center is the bearing line, an operation which requires that the bracket shims be taken out on one side and additional shims be put in on the other. It will also be apparent that by swinging the upper bracket about one side, instead of about the bearing center, it is possible to reduce the angle of line-up.

This chart was chosen because in this particular unit all methods of correction were used. The stator was shimmed to reduce the large angle of inclination. However, it could not conveniently be made plumb because the commercial sized shims were too thick, consequently the line-up was left with a smaller angle of inclination. The brackets were then shimmed to give the proper inclination to an approximate line-up.

In shimming the brackets care must be taken not to disturb seriously other important points, such as the height of the thrust bearing or the location of the runner with respect to the scroll case. These conditions sometimes limit the corrections that can be made and the whole line-up must of necessity be a compromise.

The usual standard is to bring the horizontal center of each bearing to the line desired. As the generator bearings have a clearance of 0.018 and the turbine bearing 0.008 in., these clearances enable certain liberties to be taken in departure from a perfect line-up over the vertical length of the bearing. That is why there exist on the chart lines indicating the vertical length of the bearings which have a different angle to the line, of which they are a part.

Due to the heavy weights of most of these parts and the delay caused in putting in and taking out shims, an endeavor is made to calculate from these readings the thickness of the shims required for these corrections and thereby reduce the number of corrections to be made by the usual try-and-check method. From some of the problems which have been briefly outlined, it is apparent that such a job is one requiring accuracy in readings and full appreciation of all the items which will be affected by these changes. Because it is complicated and often confusing, a chart has been prepared which graphically depicts the conditions before and after correction.

To line up a new unit with all parts lining to plumb is a tedious process, but to realign a unit which has been in service with so many fixed points is not only very tedious and slow, but requires greater ability and care than a new job.

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Pipe Welding, Ductility and New Developments Discussed at Annual Meeting of A.W.S.

HELD at the Engineering Societies Building in New York City from April 27 to April 29, inclusive, the annual meeting of the American Welding Society covered, as usual, a wide variety of activities and ideas in the field of fusion welding—including oxy-acetylene welding, arc welding, and the various forms of resistance welding. As in past meetings, also, both the scientific and practical sides of welding problems received ample attention.

Three papers dealt with pipe welding. One whole session was devoted to a symposium on the subject of ductility in welds. Another session was devoted to the welding of ships. Other papers dealt with a study of the transformation points of fusion weld metal, the cause and cure of intergranular corrosion, the welding of extruded metal, spot welding and the production welding of light gage metal specialties. Two papers dealt with new processes for high-speed gas welding.

McKibben Gets Presidency and Miller Medal

Officers elected for the ensuing year were: President, F. P. McKibben, consulting engineer; senior vice-president, A. E. Gaynor, J. A. Roebling's Sons Company. Divisional vice-presidents: New York and New England, H. N. Ewertz, Austin Hastings Co.; Middle Eastern, A. F. Davis, the Lincoln Electric Company; Middle Western, H. S. Card, the Welding Engineer Publishing Company. Directors-at-large: C. A. Adams, Harvard University; H. M. Hobart, General Electric Company; D. S. Jacobus, the Babcock & Wilcox Company; J. W. Owens, consulting engineer.

At a meeting of the board of directors, M. M. Kelly and C. A. McCune were reappointed secretary and treasurer, respectively, of the society. Committee chairmen appointed for the ensuing year were as follows: executive committee, F. P. McKibben; finance committee, C. A. McCune; meetings and papers committee, J. B. Tinnon; membership, A. E. Gaynor; revision of by-laws, A. M. Candy.

Prof. McKibben, the newly elected president of the society, was also awarded the Samuel Wylie Miller medal for his achievements in the field of structural welding.

Symposium on Ductility

The symposium on ductility was presented with the idea of bringing together various viewpoints on a controversial subject, and with the hope of eliminating some common misconceptions. Nine prominent engineers participated. The symposium was conducted under the chairmanship of F. T. Llewellyn of the United States Steel Corporation, a past president of the society and an active participant in its structural-steel work and other activities.

The various viewpoints presented may be summed up briefly as follows: Prof. H. F. Moore of the University of Illinois pointed out that the word "ductility" does not carry one single idea to all minds in industry. Some think of it as the property which permits metal to be drawn and pressed cold. To the structural engineer it means the ability of a metal to withstand many local plastic adjustments without cracking. The laboratory man thinks of ductility in terms of elongations obtained in tensile or cold-bending tests. The machine designer sometimes thinks of ductility as the property which permits a material to withstand a large number of localized minute plastic actions applied thousands of times without starting a spreading crack.

E. R. Fish, chief engineer of the boiler division, Hartford Steam Boiler Inspection and Insurance Company, defended the requirement of ductility in pressure vessels. Ductility, he said, permits the partial automatic redistribution of stresses due to temperature differentials in fabrication.

Charles H. Jennings of the Research Laboratories, Westinghouse Electric & Manufacturing Company, outlined the fundamentals of the subject as it applies to arc welds. Mr. Jennings agreed with other investigators that "ductili-

ties" obtained by tensile and bend tests are not the same. He prefers the tensile test.

Views radically different from those expressed by others were offered by C. J. Holslag of the Electric Arc Cutting & Welding Company. According to Mr. Holslag, ductility in high degree is not a desirable quality in welds, as it tends to concentrate stresses in the weld.

C. L. Waddell of the Worthington Pump & Machinery Corporation, reviewed the shift in engineering thought on welding. First, attention was concentrated on tensile strength; then it shifted to ductility. Both of these are important, he stated, yet granting reasonable strength and ductility, he said that correct engineering design of the structure is more important. Mr. Waddell's paper reviewed the results of extensive experiments made with coated and uncoated electrodes. These disclosed that under proper conditions the superior welds obtained with coated electrodes cost little more than ordinary welds.

Pointing out that there is still much to be known about the meaning and importance of ductility, Dr. D. Rosenthal of the University of Brussels said that ductility provides protection against overstressing during the shrinkage following fusion and under certain applied loads in service.

In the discussion H. E. Rockefeller, Linde Air Products Company, felt that Mr. Fish had overemphasized the need for ductility. A. M. Candy, Westinghouse Electric & Manufacturing Company, discussing the paper by Mr. Jennings, said that highly ductile welds might actually lead, in some cases, to the damaging of the parent metal by localized stresses. He said particularly that such applications as machinery bedplates do not require ductile welds.

Ductility Not the Prime Factor in Weld Dependability

All of the symposium papers were discussed in a summary by J. H. Critchett, vice-president, Union Carbide & Carbon research laboratories. He found that of all the participants only two, Mr. Fish and Professor Rosenthal, recommended more than a moderate degree of ductility. His own viewpoint was that ductility is a minor factor except as it permits a structure to stand accident and abuse and as it is required in certain cases for ease of fabrication.

More important elements in welded construction, concluded Mr. Critchett, are sound design, high-grade materials, careful attention to fabrication and thorough testing before use.

Progress in Pipe Welding

Discussing new aspects in pipe welding, with particular reference to the use of welding elbows and other welding fittings, Willard P. Curley of "Tube-Turns" reviewed the history of the application of welding to pipe.

Among the outstanding installations of welded piping mentioned by Mr. Curley was one for a large utility in one of the Southern states designed for 600 lb. pressure and 720 deg. F. temperature. The plant is now operating at 448 lb. pressure. V-type butt-welded joints in the main steam piping carry the full steam pressure. The tests upon completing the job, as well as the operation of the plant today, indicate that the installation is satisfactory in every respect. Both shop and field welding were used.

Said Mr. Curley, "The increasing number of projects in which welded pipe joints, without reinforcement, are carrying the full boiler pressure is gradually overcoming the reluctance to accept welding in high-pressure installations." He believed that engineers in general are coming to look upon the weld reinforced with straps or otherwise with suspicion, feeling that the reinforced joint "builds in" more stresses than it protects against.

Mr. Curley pointed to the tremendous economies that could be secured if the full possibilities of welding were utilized. For example, present wall thicknesses of piping are determined on the assumption that the pipe is to be threaded. With welded piping a considerably smaller thickness could be used with entire safety and satisfaction. He asked that consideration should be given to pipe standards for welding.

A paper by T. N. Greene of the Linde Air Products Company dealt with piping, with particular respect to weld ductility. It was presented in the ductility symposium. Mr. Greene concluded his paper as follows:

"1. A ductility of 10 to 12 per cent seems sufficient to meet all service requirements of pressure piping. While ductility far exceeding this range can be readily secured in fusion welds, there appear to be no requirements in piping services which would justify any higher ductility requirement.

"2. Strength in the weld metal equivalent to the base metal and quality or freedom from imperfections are of far more importance than relatively high ductility."

Welded Piping for High-Pressure Steam

Directly in the power field was the paper on pipe welding for a high-pressure steam plant. This dealt with the piping installation made by the Public Service Electric & Gas Company of New Jersey in its Burlington generating station. The authors of the paper were E. B. Severs and W. P. Gavit, the latter presenting it.

This equipment operates at a pressure of 734 lb. per square inch and a temperature of 860 deg. F. There is also a secondary steam system operating at 200 lb. per square inch and a maximum temperature of about 600 deg. It was decided to use welded joints throughout both the 730-lb. and the 200-lb. steam systems, and also for the boiler feed system. Only where pipes connect to valves, turbines, boiler outlets, etc., are flange joints used.

The pipe used for the high-pressure system is seamless steel tube in sizes up to 15 in. This pipe was made up in the fabricator shop into sections as long as could be shipped and handled in erection. The shop welds were made by the electric arc process, and were then annealed by placing the entire piece in a furnace. All field welds were made by the oxy-acetylene process and locally annealed.

Great care was used in selecting and supervising the men used in the field welding. In doing this work, however, it was found that the test requirements for Class 1 A.S.M.E. Unfired Pressure Vessel Code were unduly severe and also impracticable, according to the author. A minimum of 45,000 lb. per square inch was therefore accepted for the reduced section tensile test, and a minimum of 12 per cent for the ductility requirement.

All pipe joints for pressure of 200 lb. per square inch and over were reinforced with welded straps. These straps were bent so that their ends would bridge the weld and lie flat against the pipe on each side. Joints made in the field were annealed by the use of a special portable furnace, gas-fired (oil-fired), that could be clamped around the pipe in position.

Reinforcing Straps Questioned

Discussing this paper, several speakers expressed the opinion that the strap reinforcing used was unnecessary and that, in fact, the stresses in the welds would actually be less if this reinforcing were omitted. It was pointed out that these straps, like flanges projecting from a pipe, do not follow the temperature of the pipe closely during rapid temperature fluctuations and that differential temperature strains are thus set up.

A paper dealing with the welding of wrought iron pipe was presented by James Aston of A. M. Byers & Company. Mr. Aston stated that fusion welds of wrought iron may be made with entire satisfaction by any of the customary methods with suitable minor modifications of the procedure. He gave some suggestions for the technique to be followed in welding this material.

Electronic Magic at Welding Dinner

A talk on "Electronic Magic, Present and Future," by O. H. Caldwell, editor of *Electronics*, featured the annual dinner of the society in the Hotel New Yorker. Mr. Caldwell's talk was followed by sensational electronic demonstrations and stunts, such as the automatic photographing of a "crime" with the aid of the photo-electric cell, the use of the photo-electric cell to test golfers and to count people going one way but not the other, the thyraton organ, the stroboglow, the electronic 'cello, the electronic fire extinguisher, etc. In these demonstrations the General Electric Company and the Westinghouse Electric & Manufacturing Company were prominent participants.

READERS' PROBLEMS

FIGURING EXCESS AIR FROM OXYGEN—*Why should not the excess combustion air in routine boiler operation be figured from the oxygen analysis of the flue gas rather than from the CO_2, in view of the fact that this oxygen is actually the excess;* N.T.H.

Assuming that the analysis of the flue gas is to include no more than one constituent, oxygen will serve as the base in place of CO_2 if desired. In some respects the oxygen base is preferable. In others the CO_2 is preferable. Oxygen is a more direct indicator and easier to use in mental computations. Its disadvantages are chiefly in the analysis itself.

All engineers are familiar with the fact that for a given percentage of excess air the percentage of CO_2 is highest with anthracite coal, a little lower with bituminous coal, substantially lower with fuel oil, very much lower with natural gas and nothing at all if pure hydrogen gas is burned. Yet the oxygen measurement would be about the same with all of these fuels for the same percentage of excess air.

In a sense the CO_2 shows the air that *does* "burn" (the theoretical amount required) except that it does not show the amount which burns with hydrogen to form water. So the more hydrogen there is in the fuel the greater is the amount of air burned which does not show up as CO_2. The flue-gas oxygen, on the other hand, shows the air which does *not* "burn." This is not affected by the amount of hydrogen in the fuel except for a small correction which may be neglected in rough calculations.

To make rough calculations of excess air from the oxygen assume 21 points (always the same) of oxygen in the air supplied. Subtract the points of oxygen found in the flue-gas analysis. The difference is the points "burned." Divide the points excess (not "burned") by the points "burned" and multiply by 100 to get the percentage of excess air regardless of the kind of fuel used.

Thus if fuel oil is burned and the flue gas shows 6 per cent oxygen, proceed as follows:

Points oxygen supplied....	21
Points oxygen excess	6
Points oxygen burned	15

Percentage of excess air $= 6 \div 15 \times 100 = 40$ per cent

Oxygen is less commonly used in power plant work than CO_2 because the pyrogallic acid solution used to measure it is less rapid, certain and convenient than the caustic solution for CO_2. Phosphorus sticks for determining oxygen are convenient and reliable, but should be handled by an expert to avoid the hazards of fire, burns and poisoning.

STEAM PIPE EXPANSION—*What allowance should I make for expansion in length of a 125-ft. run of 3-in. covered steam pipe that is used with steam at 200 lb. gage pressure superheated 150 degree?* V.G.B.

It may be assumed that the pipe is at the same temperature as the steam which it carries. At 200 lb. pressure the saturation temperature is 388 deg. Thus when superheated 150 deg. the temperature of the steam, and therefore of the pipe, will be 538 deg. If the pipe were erected when the temperature was 60 deg. the change in temperature between hot and cold conditions would be 538 — 60 = 478 degree.

For iron and steel pipe the mean coefficient of expansion for this temperature range is about 0.0000065 of the length per degree change in temperature. The total expansion in your case is then $478 \times 0.0000065 \times 125 \times 12 = 4\frac{5}{8}$ in. Expansion joints or changes in pipe direction should be provided so as to permit this increase in length of pipe without causing undue reactions at the pipe anchors or unsafe stress in the pipe material.

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Cures Offered for Corrosion Of Natural-Gas Stack

Cement-gun lining, blanket insulation, protective paint and air dilution of stack gases proposed by readers answering question published April 12

WE HAVE recently supplanted coal fuel with natural gas under our two Stirling-type boilers of 2,600 and 1,500 sq.ft., respectively. The boilers are connected with a steel smoke stack designed for coal use. The stack has become very unsightly on account of the large amount of condensation due to the hydrogen in the gas fuel. The stack has a diameter of 54 in., is 140 ft. above the floor, 125 ft. above damper. One half is made of $\frac{3}{16}$-in. steel, the other half of No. 8. Our maximum rating on the larger boiler, which we use most of the time, is 130 per cent. The gas temperature at this rating is 412 deg. F., draft 0.07 in. of water. What is a reasonably inexpensive method of saving the stack from deterioration? C.O.

Corrosion-Resistant Paint

I HAD a similar experience with a steel flue of rectangular section and about 95 ft. long. Serious corrosion was discovered a few months after it was put in service (Nov. 1930). It was decided to paint the interior with a commercial paint which was highly recommended for its resistance to corrosion. Before painting, the metal was sand-blasted to produce a bright surface.

This flue is 6 ft. wide by 5 ft. high at one end, 6 ft. wide by 10½ ft. high at the other and about 95 ft. long, with a flat bottom and semicircular top. Three men cleaned the sides and top in about 18 hours.

The bottom was protected by a course of firebrick (second-hand) laid in loosely, flat side down, and grouted with a thin mixture of fireclay.

About five hours was required to lay the bricks in place and grout them in with a crew of eight men. Five painters did the painting in about seven hours.

This flue has been inspected several times since the job was done and all corrosion has stopped.

The paint which was used was guaranteed to stand 1,200 deg. F. temperature and to withstand corrosion.

C. B. HUDSON.

North Plymouth, Mass.

Special Asphalt Coating Used in Gas Regions

SEVERAL industrial and central station plants operating in districts near the Louisiana and Texas natural-gas fields encountered difficulties similar to those described by C. O. It was found that the application of a steam-distilled asphalt in emulsified form to the interior surface of the steel stack effectively stopped further corrosion of the surface by condensation of the water vapor content of flue gases from natural gas.

Where severe stack corrosion difficulties are not encountered it is estimated that one gallon of the emulsified asphalt will cover approximately 75 sq.ft. surface. In this case it would be safer to apply a heavier coat to the interior surface of the stack and allow about 50 sq.ft of surface covered per gallon coating. This coating costs about 75 cents per gallon. The cost of the material for the stack described would then be about $30. Since the coating requires only a simple mixing operation and is applied cold with a brush, unskilled labor may be used for painting the interior surface of the stack.

New York City. R. S. JULSRUD.

Suggests Insulating Blanket

THE STEEL STACK is an excellent radiator of heat, which naturally results in a decided drop in temperature of flue gases as they escape. These high-temperature flue gases, laden with water in vapor form, will give up the excess of water just as soon as their temperature is reduced below the corresponding temperature of 100 per cent saturation.

The elimination of the detrimental effects of sweating in the stack therefore resolves itself down to the problem of controlling the stack temperatures, maintaining a small temperature differential between the point of entrance and the top of the stack. This can be accomplished by insulating the stack.

A suitable form of insulation for a stack of this type is a flexible blanket of suitable thickness, fabricated between copper-bearing metal fabric, over which is applied a ½-in. coat of insulating cement, and waterproofed with a ¼-in. coat of some suitable material. A stack insulated in this manner will eliminate sweating and result in higher stack temperature and improved draft.

The Eagle-Picher Lead Company.
Joplin, Mo. GEORGE P. DIERS.

The Cheapest Solution

THE TROUBLE experienced by "C.O." is a common one especially when coal-fired boilers are converted to gas firing. The two principal causes of the excessive moisture formation in the stacks are:

1. The increased amount of water vapor formed in the flue gas because of the increase in the hydrogen content of the fuel.

2. The lowered exit gas temperature over that existing when coal was used as a fuel.

Because of the increased stack losses it is not feasible to increase the stack temperature to decrease the amount of condensation. Neither is it usually economical to insulate the stacks to prevent loss of heat. However, from the dimensions which C.O. has given for his stack—namely, 54-in. diameter and 125 ft. above the boiler dampers—ample draft should be available with a flue temperature of 412 deg. F.

The elevation above sea level was not given, but for an average low elevation the draft at the boiler dampers should be close to 0.70 in. If this much draft is available C. O. should have more than is necessary for natural-gas firing.

If an opening is provided in the stack above the boiler dampers for the admission of additional air, the stack gases will be diluted enough, so that the dew point will be raised to a point where little condensate will form. If when the opening is made into the stack a baffle is placed in such a position as to divert any down drafts that may exist, danger from flare-back and pulsations in the boiler furnace will also be prevented.

P. K. RICHARDSON.
Salt Lake City, Utah

Apply Lining With Cement Gun

THE CONDENSATION of water vapor from the flue gases is due to the fact that the stack is much larger than required for the maximum rating stated. Hence the velocity of the gases in the stack is very low, and the radiation from the surface of the stack reduces the temperature of the gases to the point where a large amount of the water vapor is condensed.

I have assumed that the fuel burned is natural gas smiliar to that from the Oklahoma or Texas Panhandle fields, and that it has a gross heating value of about 970 B.t.u. per cubic foot. With proper burners, such a gas can be burned with about 10 per cent excess air. With a stack temperature of 412 deg. F., the boiler efficiency should be about 78 per cent.

With the boilers operating at rating I estimate that the total hourly products of combustion will be 10,730 lb. of dry flue gas and 1,430 lb. of water vapor.

The radiation from the unlined steel stack will be about 3 B.t.u. per square foot per hour per degree temperature difference. Hence, with an outside temperature of 70 deg. F., and with the gas passing through 125 ft. of the stack, the radiation will reduce the temperature at the top of the stack to 212 deg. F., and will condense 43 per cent of the water vapor in the gas. Since this amounts to over 600 lb. of water per hour it is no wonder that the stack deteriorates.

This can be prevented, at a considerable sacrifice in boiler efficiency, by increasing the amount of excess air. This will raise the initial stack temperature and increase the weight of dry flue gas. But in order to prevent condensation by this method about 80 per cent excess air would be required. Hence this method should be employed only as a temporary expedient, if the stack is now in a dangerous condition, to prevent further corrosion until the stack can be taken out of service to apply a permanent remedy.

The best method of permanently solving this problem is to line the stack. The stack is so large that the reduction is cross-section on account of the lining would not be detrimental. In my opinion, the best lining would be two inches of concrete applied over wire mesh by means of a cement gun. Such a lining would greatly strengthen the stack where it has been already weakened by corrosion.

Many stacks lined in this manner are giving good service. The lining will reduce the radiation to about 0.65 B.t.u. per square foot per hour per degree temperature difference. At rating the gases issuing from the stack will be well above 300 deg. and no condensation will take place. Furthermore, even though condensation does take place at very light loads, the lining will protect the steel from further deterioration.

The cost of such a lining will depend upon a number of factors not stated in the question, but probably will not exceed $1,000, including the wire-mesh reinforcement.

Brick could be used for the lining. But this would probably cost more, unless suitable brick and labor were available locally. In either case, the effect of the increase in average stack temperature would more than offset the effect of the reduction in stack cross-section, and thus increase the available draft at the boiler damper.

If the stack is supported on building steel which is not strong enough to support a brick or concrete lining, a smaller stack built of No. 8- or No. 10-gage steel plate can be placed within the present stack. C. A. BUTLER, JR.
Kansas City, Mo.

Two Questions on Babbitt for Our Readers

THE FOLLOWING two questions on babbitt and babitting are submitted for the consideration of "Power" readers. Answers to both will be published in the same issue. Readers submitting answers to both questions should keep them separate to avoid confusion.

QUESTION 1

FOR babbitting high speed bearings we use alloy No. 2, A.S.T.M. Specification B-23, which is commonly recognized as the original composition of genuine babbitt. New material is purchased in ingot form, but we always have on hand an accumulation of reclaimed ingots made by remelting babbitt chips, which often contain chips of other materials, such as cast iron, steel, brass or bronze. The latter are skimmed off or left in the bottom of the melting pot when casting ingots or reclaimed metal, so that the resulting material is probably of nearly the correct analysis. We should like the opinion of Power *readers regarding the recommended maximum allowable percentage of reclaimed babbitt which may be mixed with new metal for babbitting high-grade, high-speed bearings.* D.L.B.

QUESTION 2

WE ARE experiencing trouble with main bearings in our high-speed Diesel engines, due to poor bonding of babbitt to the cast-steel shells. Will the readers please offer suggestions for improving the bonding by the various methods they have undoubtedly tried? What is an infallible method for detecting poor bonding prior to installing the bearings. Have any tried a scleroscope, or anything similar? Comments will be greatly appreciated. W.A.H.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.

WHAT'S NEW IN PLANT EQUIPMENT

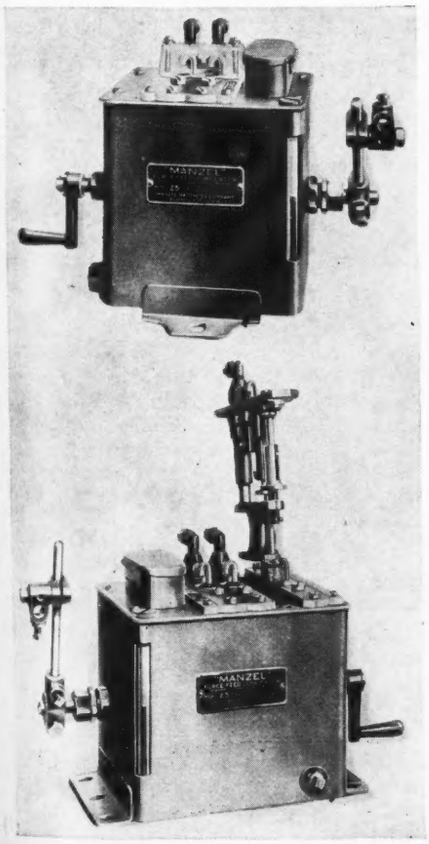
Improved Force-Feed Lubricator With Removable Pumping Units

A RECENT ADDITION to the line of force-feed lubricators put out by Manzel Brothers Company, 315 Babcock St., Buffalo, N. Y., is Model 25 lubricator illustrated. The new model is designed to deliver oil of any viscosity in accurately measured quantities against the high steam, gas and air pressures now generally used on engines, pumps and compressors. It retains the salient features of the standard lubricators put out by the company and in addition certain important improvements.

Like previous models, this lubricator is built on the double-plunger principle, with an individual pumping unit for each point to be lubricated. Any unit may be removed without stopping the lubricator or the equipment on which it is installed, or in the case of multiple-feed lubricators without interfering with other units. The discharge valves are in separate cages independent of the pumping units and may be removed by simply unscrewing the cylinder outlet connection. Also, the valve cages, complete with valves, may be removed and the valves reseated, cleaned or replaced without taking the unit from the reservoir.

Each pumping unit is independently adjustable and may be regulated while the lubricator is in operation. Any unit may be adjusted to supply from a fraction of a drop to a maximum of thirteen drops of oil with each plunger stroke. The sight feed shows the actual amount of oil being delivered by each feed. It is not under pressure and may be removed for cleaning or other purposes without interfering with the operation of the lubricator. A large filling cup permits of convenient filling of the reservoir, the cup being fitted with a hinged cover and removable strainer. A corner gage glass is provided to show the height of oil in the reservoir, and a hand attachment for use before starting the engine or if more oil is needed momentarily.

Model 25 lubricators can be furnished with from one to thirty feeds, in any desired capacity, and with either ratchet, rotary or direct drive. Standard outlet fittings are for $\frac{1}{4}$-in. o.d. tubings with $\frac{5}{16}$-in. o.d. tubing or $\frac{1}{4}$ or $\frac{1}{8}$-in. iron pipe fittings optional. For ammonia compressors the lubricators can be furnished with all steel and iron parts, and double-compartment lubricators for feeding two kinds of oil can also be supplied.

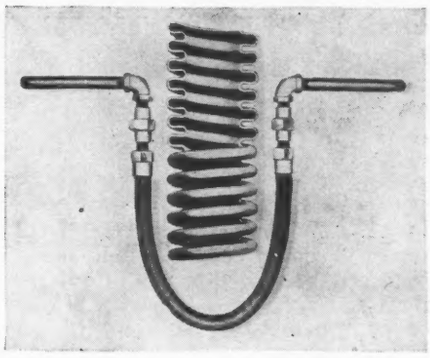


Manzel Model 25 double-feed, right-hand, rachet-drive lubricator (above), and four-feed unit (below), showing ease of removing pumping unit from reservoirs

Seamless Metallic Hose

SOME of the important uses for which the seamless, flexible metallic tubing put out by the Bendix Aviation Corporation, South Bend, Ind., is particularly adapted are, fluid connections between moving parts; absorption of vibration and conveyance of liquids, semi-liquids, steam or gas. The hose is seamless from the tip of one fitting to the tip of the fitting at the opposite end because the fittings are brazed or welded, forming an integral part of the hose.

Made of special bronze alloy seamless pipe, the hose is corrugated in round-thread single lead deep wall form, as shown. A protective casing braided from copper covers the hose in either one, two or three layers, depending on the pressure the hose must withstand. For certain uses this braid covering is further protected by an interlocked galvanized steel casing over all. The hose is being manufactured at present with internal diameters of $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 inch.

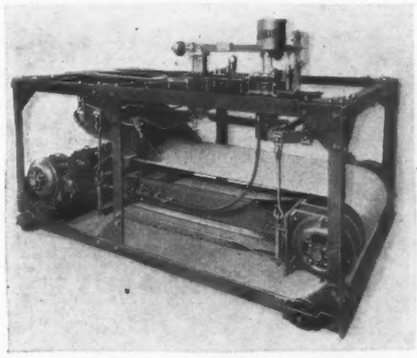


Cut away view of internal corrugated wall and section of hose complete with ends

Conveyor Scale Equipped With Photo-Electric Unit

THE USE of a light-sensitive cell as a means of totalizing the weight of materials transported is a feature of the Telepoise feeder and conveyor scales now being put out by John Chatillon & Sons, 85 Cliff St., New York City. The illustration shows a unit designed to control the coal fed to stokers and at the same time weigh it. The photo-electric unit is employed in conjunction with a special device to convert electric impulses into pounds, barrels, short, long or metric tons.

Elimination of parts subject to wear, adjustments and replacements are some of the advantages of this modern improvement. It is positive and instantaneous in operation. Weigh beams and levers are not employed as prime movers for any device; they are free to indicate the weight on the scale, which is electrically transmitted to a register, indicator or recorder or a combination of any two or all three of these instruments. Positive automatic control can be furnished with the scales which will prevent a down-spout, hopper or bin from overflowing or being emptied.



Telepoise feeder and conveyor scales equipped with photo-electric unit

Stud-Tube Type Water-Cooled Furnace Wall

THE DEVELOPMENT of a new water-cooled furnace wall construction, designated as the Bailey stud-tube wall, is announced by the Babcock & Wilcox Company, 85 Liberty St., New York City. The new wall structure is designed to supplement the present Bailey wall constructions and to extend the range of conditions to which that water-cooled furnace may now be applied.

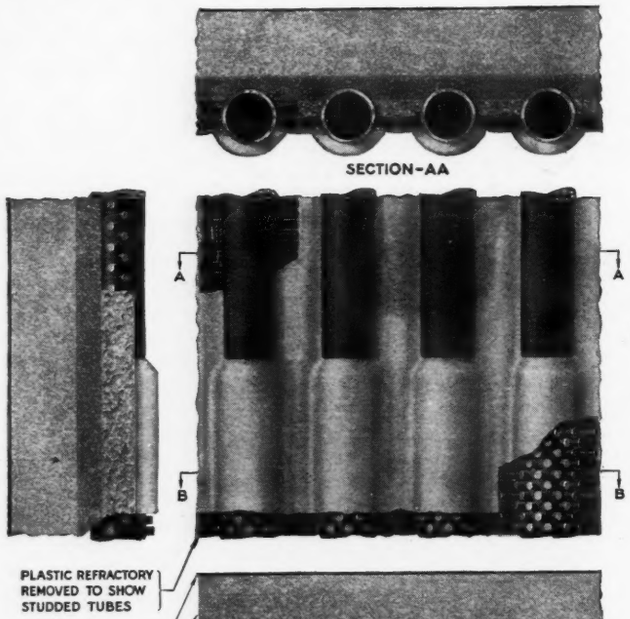
A detail arrangement of the stud-tube furnace wall is shown in Fig. 1. The lower portion of the wall is completely coated for use in the hotter portions of the furnace and those zones receiving severe punishment. The wall construction consists of water-cooling tubes spaced in the usual manner, but instead of being fitted with blocks clamped in place, iron studs are welded to the tubes and plastered over with refractory of suitable conductivity and thickness to give the desired rate of heat transfer and close the spaces between the tubes to make an airtight wall.

The upper portion of the wall, as illustrated, in which the tubes are left exposed, represents the construction used in the cooler zones, or the upper portions of most furnaces where rapid heat absorption can take place without interfering with the efficiency of the furnace. The studs are confined to the spaces between the tubes, thereby filling the gaps, and these studs when covered with refractory complete the wall. Insulation held in place by a casing is mounted on the back of the stud tubes.

The studs welded to the tubes serve as a mechanical means of holding the refractory and slag coating, and as conductors of heat from the wall coating into the water-cooling tubes. The thickness of the wall coating may decrease due to a thinning down of the refractory or it may increase with the building up of slag or ash, but in all cases the surface of the coating is close to the equilibrium temperature representing the fusion point of the fuel burned. The new wall structure is said to be highly resistant to slag action.

With this type of wall construction it is possible to vary the form and character of the wall surface to meet combustion requirements for any kind of fuel being burned.

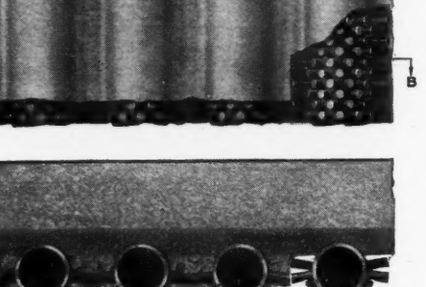
One of the distinctive features of the stud-tube wall construction is flexibility of shape. The tubes can be bent to any desirable radius to form arches, openings for burners, access and observation doors and form bends or other curved wall surfaces, the studs on the tubes providing continuous reinforcement for the moldable refractory.



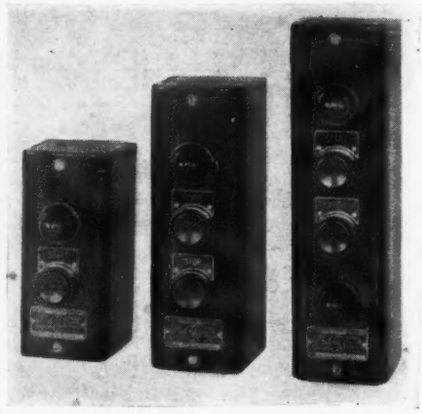
Furnace side and cross-sectional views of Bailey stud-tube wall

New Welding Heads

A NEW SERIES of welding heads with detachable tips has been introduced by the Linde Air Products Company, 30 East 42d St., New York, N. Y., for use with the Oxweld Type W-17 welding blowpipe. The new tip gives the same type of flame as that produced by the one-piece welding head for the Type W-17 blowpipe. Sizes No. 6 to 13, inclusive, are available in the new heads.



New welding heads with detachable tips



Push button stations for front-of-panel or wall mounting

Unit-Type Heavy-Duty Push-Button Stations

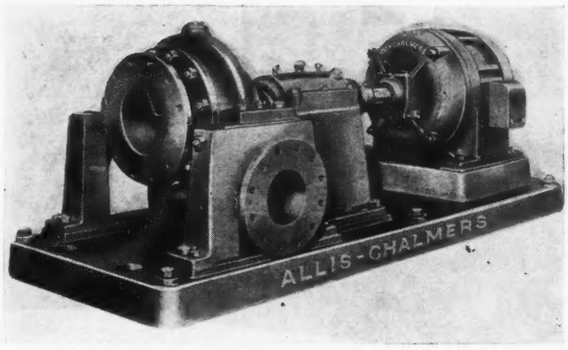
A NEW LINE of push-button stations (Type CR-2940), designed for general industrial applications is illustrated. The stations are divided into three general classes: those which make momentary contact, those which maintain the contact, and a combination of both. With a momentary contact the circuit is completed or interrupted only as long as the operator's finger depresses the button. This is required when the station is used with a controller that must provide undervoltage protection. A maintaining contact holds the circuit open or closed as does an ordinary knife switch.

The momentary-contact, push-button unit provides both a normally open and a normally closed circuit. Heavy, double-break contacts are employed and a rolling contact is obtained on both normally open and normally closed positions. Allowance for ample creepage distances from live parts to ground makes this device suitable for operation on 600-volt circuits.

Stations are also available in a modified form for mounting on the back of $\frac{1}{2}$- to 2-in. panels. Only the buttons extend through the panel, and they are protected by the same collar and designated by the same nameplates as are used on the wall-mounted units. The stations are put out by the General Electric Company, Schenectady, N. Y.

Centrifugal Pumps for Handling Hot or Cold Acids

DESIGNED especially for handling hot or cold acids in process work, the Type SSA pump, put out by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., is of the single-suction type, and all parts coming in contact with the acid pumped are made of chrome steel. To insure uniform expansion from the center of the pump when handling acids of high temperature, the casing is supported on the horizontal centerline by brackets, and it



Allis-Chalmers type SSA centrifugal pump for handling hot and cold acids

is also keyed on the vertical centerline underneath the water-cooled stuffing box.

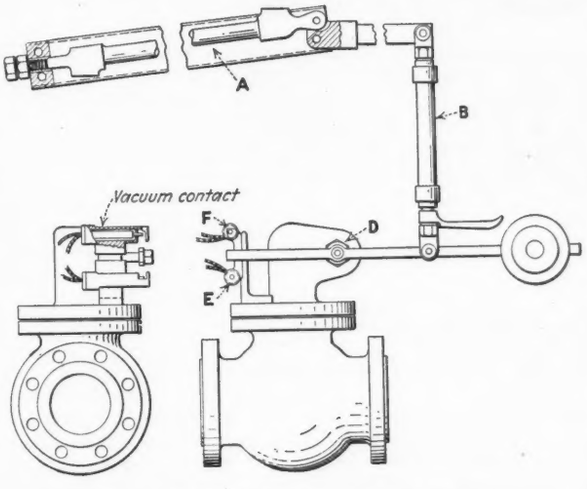
The pump is so constructed that the rotating element, including the self-aligning, anti-friction, bearings and the flexible coupling, can be removed through the suction end of the pump without disconnecting the discharge piping or casing brackets or disturbing the motor.

Signal Device for Feed Water Regulator Control Valve

AN ELECTRIC signal device for use with the control valve on the Copes feed-water regulator was announced some time ago by the Northern Equipment Company, Erie, Pa. It gives instant warning of any abnormal condition in the boiler-feed supply by signalling, by means of a bell or an electric light, if the valve reaches the wide-open or fully-closed positions.

Referring to the illustration: When expansion tube *A* of the Copes thermostat contracts with rising water level, the motion is transferred through the vertical strut connection and tension relief *B* to raise the weighted lever, gradually closing the valve. This lever pivots at the stuffing box *D* and the extended end moves downward. Should some abnormal condition cause the valve to reach a fully-closed position, the lever striking vacuum contact *E* closes the alarm circuit for the "closed" signal.

As the water level in the expansion tube lowers, the tube expands, permitting the weighted lever to open the valve gradually. Should the fully-open position be reached, the extended end of the lever strikes vacuum contact *F* and closes the circuit for the "open" signal. The vacuum contacts are fully protected in a metallic case which is adjustable to any desired position. The signal may be installed on any Copes control valve.

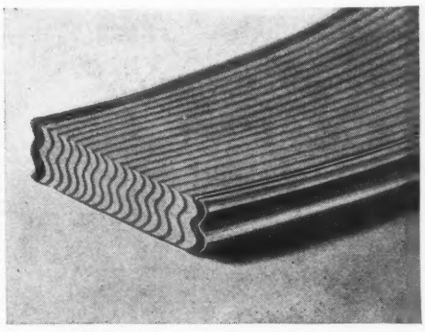


Signal device installed on control valve

Combination Metal and Asbestos Gaskets for High Pressures and Temperatures

DEVELOPED especially for service on boilers, pipe lines and other equipment subject to frequent or rapid temperature changes or where vibration is encountered, the new Garlock Guardian gasket is said to give safety against any pressure or temperature, resistance to gases and liquids, tight joints under changing temperature and continued resiliency in service.

Section of Garlock Guardian gasket



The gasket is made from a metal ribbon shaped to give resiliency, then wound with intervening layers of asbestos. It is available in a wide range of sizes and shapes from the Garlock Packing Company, Palmyra, N. Y.

Indicating Meters for Liquids and Gases

THE ILLUSTRATION shows the orifice and through-flow types of rotameters now being put out by the Schutte & Koerting Company, 1165 Thompson St., Philadelphia, Pa. The meters are designed to indicate the rate of flow in a pipe line and are suitable for gases or liquids and give direct readings in cubic feet, pounds, gallons or other units per hour or per minute.

The operating principle of the two types illustrated is the same—a free top-shaped float held in suspension by the upward flow in a vertical transparent tube, the position of the float indicating the actual rate of flow and the readings being taken from a scale on the float tube.

The orifice type shown at the left is designed for horizontal pipe lines carrying large quantities of gas or liquid. The flanged body contains an orifice plate which produces a slight pressure difference and induces a proportional flow through the rotameter tube. This type is made in sizes from 4 in. up, and for special operating conditions it is made of corrosion-resisting alloys.

The through-flow type shown at the right is built for small and medium sizes of pipe lines. It has screwed connections and is made in sizes up to 3 in. It can be used in horizontal or vertical pipe lines and is available in bronze aluminum, iron, lead and other metals.

Orifice and through-flow type of rotameters

NEWS of the FIELD

Program Announced for A.S.M.E. Oil and Gas Power Meeting at Penn State, June 8-11

TENTATIVE PROGRAM has just been announced for the fifth national meeting of the Oil and Gas Power Division of the American Society of Mechanical Engineers, which will be held at Pennsylvania State College, State College, Pa., on June 8 to 11 inclusive. Twelve technical papers and reports, an exhibit of oil and gas engine parts and several social events are among the features scheduled on the program.

The meeting will be opened on Wednesday morning, June 8, by Professor F. G. Hechler, chairman of the local committee on arrangements. A paper will be presented at this session on "Problems in the Preheating of Oil," by Edward A. Richardson. The afternoon session will be devoted to the gentral subject of "High-Speed Diesel Developments," with the following papers to be read: "High-Speed Engines," by Julius Kuttner; "Fuel Spray Formation," by Dana W. Lee; "Penetration of Oil Sprays," by P. H. Schweitzer; and "Characteristics of Jerk-Pump Injection Systems," by O. F. Zann.

At the session on Thursday morning Russell J. Allen will discuss "Metallurgical Problems of Diesel Engines," and E. G. Beardsley and J. N. Mackendrick will present a paper on "Fuel Injection in Gas Engines."

The Friday morning session will be devoted to the "Diesel Power Cost Committee Report" and the "Diesel Fuel Research Committee Report." At the annual banquet in the evening Professor C. M. Allen, of Worcester Polytechnic Institute, will speak on the topic "Use and Abuse of Gasoline."

On Saturday the meeting will close with the morning session, at which the following papers will be presented: "Burning Heavy Oil in Diesel Engines," by H. W. Stalnaker, and "Inertia Supercharging of Engine Cylinders," by E. S. Dennison.

Some of the latest developments in the field will be shown at the exhibit of engine parts and accessories which will be held in the college armory, directly across the street from Schwab Auditorium, where the technical sessions will be held. Professor Kalman De Juhasz will be in charge of the exhibit, which will be open throughout the course of the meeting.

A mountain excursion and picnic, a golf tournament, special drives through the surrounding country, the annual banquet and separate events for ladies are some of the features of the entertainment program.

Construction of Herndon Plant Again Postponed

AT THE ANNUAL MEETING of the stockholders of the San Joaquin Light & Power Corporation held in Fresno, Calif., recently, A. E. Wishon, president, stated that construction of the company's proposed steam plant at Herndon, ten miles north of Fresno on the San Joaquin River, would be deferred until a date that will bring it to completion in time to handle the peak load demand in 1934. As a result of the heavy rain and snow last winter, Mr. Wishon explained, the company's hydro-electric plants will be able to take care of all demands in the immediate future.

Supreme Court Upholds G. O. Smith's Appointment

THE SUPREME COURT of the United States decided May 2 that George Otis Smith holds lawfully the office of member and chairman of the Federal Power Commission.

The title to the office was challenged before the court on behalf of the United States Senate. The Senate, according to the opinion of the court, first consented to President Hoover's nomination of Mr. Smith and sent a notification thereof. Thereafter, and within two actual days of executive session as provided by its rules, the Senate reconsidered its action and declined to approve the nomination.

In a unanimous decision, the court ruled that the Senate did not have the power, on the next day of executive session, to reconsider its action, where meanwhile, pursuant to its order, the resolution of consent had been communicated to the President, and thereupon the commission had issued and Mr. Smith had taken the oath of office and entered upon the discharge of his duties.

The natural meaning of the order of notification to the President, it was held, "is that the Senate consents that the appointment be forthwith completed and that the appointee take office. This is the meaning which, under the rules, a resolution bears when it is sent in normal course after the expiration of the period for reconsideration. Notification before that time is an exceptional procedure, which may be adopted only by unanimous consent of the Senate. We think it a strained and unnatural construction to say that such extraordinary, expedited notification signifies less than final action, or bears a different meaning than notification sent in normal course pursuant to the rules."

Norris Proposes Equal Rates Based on Production Costs

UNDER AN AMENDMENT to the Federal Power Act proposed recently by Senator Norris of Nebraska, it would be unlawful to sell electric energy in one community at a rate higher than in another community, unless there is a difference in the cost of production. In case of a difference in the cost of production, the fluctuation in rates would not be permitted to exceed the percentage of difference in production costs. It is proposed that this provision be applied equally to interstate and intrastate companies, apparently on the supposition that otherwise there would be discrimination.

Enforcement would be placed entirely in the hands of the Federal Power Commission. The commission would be able to act upon the receipt of any complaint as to diversity of rates not attributable to disparities in production costs. In exercising its power in this connection, the commission is directed to employ the same procedure as followed by the Interstate Commerce Commission in regulating railroad rates. Municipal plants are expressly excluded from the provisions of the bill.

In order to eliminate possibilities of

escaping the regulation, it is stipulated that all property sold or transferred by power companies shall be sold or transferred subject to the understanding that the transaction shall not permit evasion of the amended act. A fine of $5,000 is provided for violations of the act. The amendment has been referred to the Senate Interstate Commerce Committee which is headed by Senator Couzens of Michigan.

Boiler Sales 50% Under 1931; Stokers and Pulverizers Off

SALES OF BOILERS for the first three months of this year were approximately 50 per cent under those for the corresponding period of 1931, new orders for mechanical stokers dropped 30 per cent and sales of pulverizers were 35 per cent less, according to reports just issued by the United States Bureau of the Census.

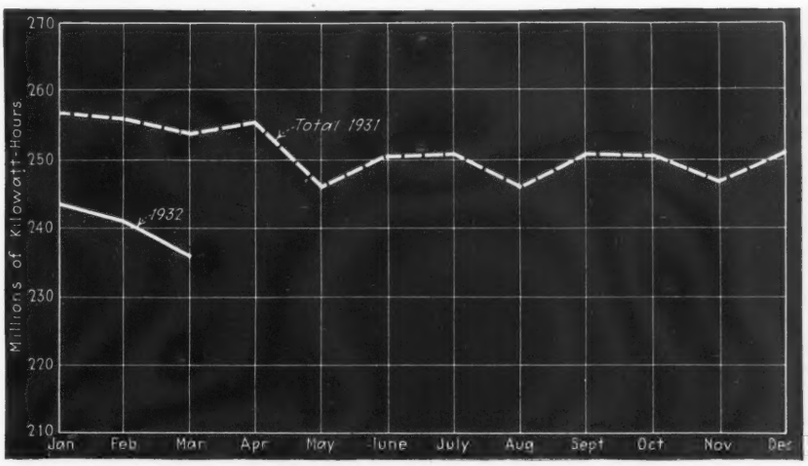
In the first quarter of 1932 orders were placed for 750 boilers of 884,977 sq.ft., compared with orders for 1,642 boilers of 1,745,377 sq.ft. in the first three months of 1931. This year 282 boilers were sold in January, 204 in February and 264 in March. The following table gives the number, kind and square footage of all boilers sold in the first three months of 1932 and 1931:

Kind	1932 No.	1932 Sq.Ft.	1931 No.	1931 Sq.Ft.
Stationary:				
Water-tube.....	96	489,890	169	793,088
Horizontal return tubular...	57	65,978	112	134,712
Vertical fire-tube	96	21,031	172	46,535
Locomotive (not railway).....	21	20,125	15	10,343
Steel heating....	403	179,116	998	489,594
Oil country.....	1	752	33	30,227
Self-contained portable.....	46	34,071	66	39,259
Miscellaneous...	5	6,005	15	11,588
Total.....	725	816,968	1,580	1,555,346
Marine				
Water-tube.....	11	57,324	31	170,393
Pipe.....	2	2,678	2	2,998
Scotch.....	12	8,007	19	6,970
Miscellaneous...	...	.....	10	9,670
Total.....	25	68,009	62	190,031

Sales of mechanical stokers of over 300 lb. capacity totaled 287 stokers of 76,085 hp. in the first quarter of 1932, compared with sales of 408 stokers of 80,606 hp. in the corresponding period of 1931. Of those sold in this year's quarter 94 were for installation under water-tube boilers of 489,410 sq.ft., and 193 were for fire-tube boilers of 271,440 sq.ft. In addition, 82 stokers of 200 to 300 lb. capacity were sold during the first quarter, together with 119 of 100 to 200 lb. and 924 of less than 100 lb. capacity.

First quarter sales of pulverizers for boiler installations amounted to 25 pulverizers with a total capacity of 113,088 lb. of coal per hour contract. New orders for the corresponding period of 1931 totaled 39 pulverizers of 341,500 lb. per hour total capacity. All those sold in the first three months of 1932 were for use in the unit system; 21 with a total capacity of 108,288 lb. per hour were for installation under water-tube boilers and 4 of 4,800 lb. per hour total capacity were for fire-tube boilers.

Public Utility Power Production Drops 6 Per Cent During First Quarter of 1932



Average daily production of public utility power plants

ELECTRIC POWER production of public utility power plants in the United States during the first three months of this year totaled 21,861,000,000 kw.-hr., as compared with 23,014,000,000 kw.-hr. produced in the corresponding period of 1931, according to figures just released by the Geological Survey of the Department of the Interior. This amounts to a decrease of 6 per cent from last year's production and a drop of 6 per cent under the production level of the same period in 1930.

As shown by the chart, average daily production of electricity by public-utility plants in March, 1932, was 236,200,000 kw.-hr., about 2 per cent less than the daily production for February and 3.5 per cent less than the daily output for January. In 1930 the average daily production for March was about 1 per cent less than in January of the same year. The normal decrease in daily output from February to March is about 2 per cent, it is stated by the Geological Survey.

Average daily production of electricity by the use of water power in March of this year was about 2 per cent less than in February, even though precipitation and therefore water supply for power plants was above normal. During the first quarter of 1932 hydro-electric power amounted to 42 per cent of the total output, as compared with 31 per cent for 1931.

Power production figures of the Geological Survey are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations, both commercial and municipal, electric railway plants, plants operated by steam railroads generating electricity for traction, Bureau of Reclamation plants, public works plants and that part of the output of manufacturing plants which is sold for public use.

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Smaller Industries Meeting At Silver Bay, July 11-16

THE 1932 PROGRAM of the Silver Bay Industrial Institute, running from July 8 to 22, will conduct special training courses on plant training, industrial supervision, and personnel, under a faculty of successful and outstanding managers and superintendents, and men who have had practical experience in the successful solution of personnel and plant training problems.

Special attention will be given to the problems of the nation's smaller industries, according to Charles R. Towson, secretary of the institute. Encouraged by the interest shown in the first conference of smaller industries at Silver Bay last year by government officials and industrialists generally, the institute board of directors has determined to conduct a yearly conference on smaller industries as a part of the regular institute program.

This year's conference will be held from July 11 to 16, and the program will be presented in the main by leaders of industry who represent the plant operation and the policy-making responsibilities of the large number of industries having fewer than 500 employees. It is intended to afford a cross-section study of the varied problems and successful methods of dealing with production and personnel.

A. V. Garratt, Consulting Hydro Engineer, Is Dead

ALLAN VINAL GARRATT, consulting engineer in hydro-electric work, died on April 30 at his home in Holliston, Mass. He was 69 years old.

Mr. Garratt was the first secretary of the National Electric Light Association. He was chairman of the first committee to draw up an electrical safety code and of the first committee on wire gage standards.

Mr. Garratt was born in Boston and was educated at Massachussetts Institute of Technology and at Harvard University. He practiced as a consultant on the Pacific Coast from 1890 until 1894 and from 1895 until 1930 was successively chief engineer, general sales agent and general sales manager of the Lombard Governor Company, Ashland, Mass.

At the St. Louis Exposition Mr. Garratt won a gold medal for notable work in methods of water-wheel governing. He was a member of the American Institute of Electrical Engineers, the American Society of Civil Engineers and the Harvard Engineering Society.

Turbine-Electric Ship Sets Pacific Record

A NEW RECORD for the steamship run between Yokohama and San Francisco was claimed for the new turbine-electric driven Dollar liner President Coolidge, which recently completed its second homeward crossing in regular service in 12 days and 8 min. This is 4 hr. and 4 min. faster than the previous record, held by the Japanese mail line Asama Maru.

The President Coolidge, which is the largest turbine-electric drive ship afloat, sailed from New York for San Francisco on its maiden voyage on Oct. 15, 1931. On her first trip from San Francisco to Yokohama in the run was made in 11 days, 4 hr. and 22 minutes.

The vessel is driven by 26,500-shaft-horse-power, twin-screw Westinghouse turbine-electric machinery. The propulsion plant consists of two 13,250-hp. synchronous motors connected directly to two generators, and a control unit for these machines. The auxiliary power is supplied by four 500-kw., d.c. geared turbine-generator sets.

A.S.M.E. Freeman Travel Scholarship in Hydraulics

THE American Society of Mechanical Engineers announces the Freeman Scholarship for 1932 in Hydraulic Engineering for study and travel abroad, of $100 per month for a period not exceeding fifteen months. This scholarship has been provided through the generosity of John R. Freeman, past-president of the A.S.M.E.

Applications, addressed to the Freeman Fund Committee, in care of the society, will be received until June 1, 1932, from American citizens under 35 years of age, who are technical graduates engaged as instructors or junior professors in technical schools, or who are engaged in the active practice of hydraulic engineering. Candidates should have a good working knowledge of the German language. Applicants should supply age, place of birth, education, experience, photograph, and have not less than six recommendations from former teachers and employers. A statement concerning the field of engineering in which the applicant proposes to work is also requested.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual summer convention at Cleveland, Ohio, June 20-24. Pacific Coast convention at Vancouver, B. C., Canada, Aug. 29-Sept. 2. Headquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society of Heating and Ventilating Engineers. Semi-annual meeting at the Hotel Pfister, Milwaukee, Wis., June 27-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Refractories Institute. Annual spring meeting at the Wm. Penn Hotel, Pittsburgh, Pa., May 18. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Smoke Prevention Association. Annual convention at the Royal York Hotel, Toronto, Ont., Canada, June 7-10. Secretary, Frank A. Chambers, City Hall Square Building, Chicago, Ill.

Universal Craftsmen Council of Engineers. Annual convention at Cedar Point, Ohio, Aug. 2. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

New Boilers Ordered for Industrial Steam Plants

CONTRACT for three stoker-fired boiler units has just been awarded to the Combustion Engineering Corporation by the Jamistown Coal and Coke Company of Hannastown, Pa., Each boiler is of the bent-tube type and contains 4,900 sq.ft. of heating surface. The stokers are of the forced-draft chain-grate type, having 130 sq.ft. of grate surface each.

An order has also been placed by the Sinclair Refining Company for a 6,150-sq.ft. Walsh-Weidner sectional-header boiler designed for 450 lb. pressure. This boiler is to be installed at the company's Coffeyville (Kan.) plant, and will be oil fired. The drum will be of welded construction throughout. This installation will also include a Neckar process boiler feed-water treatment system having a capacity to treat 317,000 lb. of raw water per hour.

Rapid Progress Made on 130,000-Hp. Masson Plant

EXCELLENT PROGRESS is being made in the construction work on the hydro-electric project of the Maclaren-Quebec Power Company, at Masson, Quebec. This plant will have an aggregate capacity of 130,000 hp., which will bring the total development of the company's plants (on completion of the remaining unit at High Falls) up to 245,000 horsepower.

At the present time the concrete dam, one mile above the power house, is practically completed. The tunnel which will connect the dam with the power house and will be one mile in length, has been drilled through solid rock to within a thousand feet of completion and the penstocks are in course of construction. The foundations of the power house are completed and the tailrace has been built.

Alberta Limits Output of Turner Valley Natural Gas

THE ALBERTA GOVERNMENT has passed legislation designed to bring about conservation of Turner Valley natural gas. The act provides for appointment of a commission of three members to supervise and control the field's resources and the bill also puts into effect a total maximum gas flow of 200,000,000 cu.ft. daily, which virtually cuts in half the present flow of gas from the wells. The board is given power to fix production at any or all of the wells and to restrict the gas flow to 100,000,000 cu.ft. daily at any time deemed necessary. Not later than Oct. 1, 1932, the board must hold an enquiry to decide the effects of the legislation.

Personals

G. F. McDougall, consulting mechanical engineer of Portland, Ore., has been elected vice-president for the coming year of the Oregon Technical Council, consisting of representatives of all the major branches of engineering in the state. The chief function of the council this year will be to direct the recently formed engineers' relief organization.

Edmund J. Walsh, vice-president of the Chattanooga Boiler & Tank Company, has been nominated by the Chattanooga Purchasing Agents Association for election to the vice-presidency of the National Association of Purchasing Agents for the fourth region.

Martin J. Insull, president of the Middle West Utilities Company, Chicago, Ill., and brother of Samuel Insull, announced May 3 that he had retired from the Middle West Utilities Company and its subsidiaries. Martin Insull is 62 years old and has been actively engaged in affairs of the company for more than twenty years.

William A. Prendergast, formerly chairman of the New York State Public Service Commission, has been elected a vice-president of the Long Island Lighting Company, New York City.

Obituary

Roy B. Champion, superintendent of public works of the City of Holland, Mich., died on April 21 at the age of 50 years. He was born in Lovelane, Iowa, and graduated from the University of Iowa in 1906. After working a year for the North Shore Electric Company, he became city electrician of Holland in 1907. He was appointed superintendent of public works in 1910, and with the exception of two years as superintendent of water works at Chester, Pa., held that position until his death. He supervised the modernization and enlarging of the municipal steam power plant, water works and other public projects in Holland. Mr. Champion was a member of the American Society of Mechanical Engineers.

B. W. Gilson, electrical superintendent of the Carnegie Steel Company, Youngstown, Ohio, for the past 23 years, died suddenly April 27 at his home in that city. A past-president of the Association of Iron & Steel Electrical Engineers, Mr. Gilson was long active in the affairs of that association. He was a native of Pennsylvania and a graduate of Hiram College. After several years experience in other steel plants, Mr. Gilson joined the Ohio works of the Carnegie Steel Company in 1894. During his 38 years with the company he held practically every position in the electrical department from crane operator to superintendent.

How's Business?

As we move into May the slight spurt of early April seems to be petering out. Steel mill activity is still slowly increasing under the uncertain stimulus of low-priced automobile production, but price structure is weakening under competitive consumer pressure and prospects of further wage cuts. Electric power production (1,454,505,000 kw.-hr. for the week ended April 30, according to the N.E.L.A.) and merchandise carloadings show slackening response to seasonal influences. Building contracts made a better showing in April and have stopped declining, but are below a subsistence basis. Commodity price averages show some tendency to stabilization, but security markets have slid off to pre-war levels under legislative uncertainties and necessitous liquidation. In spite of all these discouraging developments the basic conditions for business recovery are being quite clearly established, although they are utterly and almost universally ignored.—*The Business Week*, May 11.

Business Notes

Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., has moved into its new building at 56 Prospect Street. Fully equipped with laboratories and heating plant, this building is the first in Hartford to be completely air conditioned.

De Laval Pacific Company, 61 Beale St., San Francisco, Calif., has been appointed by the Northern Pump Company, Minneapolis, Minn., and the King-Seeley Corporation, Ann Arbor, Mich., as their distributor in Washington, Oregon, California, Idaho, Nevada, Arizona, the west coast of Mexico and Central America, Alaska, Hawaiian Islands, Philippine Islands, Japan and China.

Dravo-Doyle Company, Pittsburgh, Pa., has acquired the sales and engineering business of the Rush Machinery Company, distributor for the Iron Fireman Manufacturing Company and other engineering lines in the Pittsburgh district. R. M. Rush will continue as manager of the business, which will be conducted as the Rush Machinery Division of the Dravo-Doyle Company.

Mundet Cork Corporation, New York City, announces a change of personnel at its Memphis (Tenn.) branch office, located at 499 North Front St. Howell E. Adams has resigned and his position as manager of the branch has been assigned to R. H. Hunter, formerly in the employ of the Armstrong Cork & Insulation Company and the York Ohio Ice Machine Company.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., announces the appointment of Alf Herschel, formerly Philadelphia port engineer, as marine sales service representative for the East Coast, with headquarters at the company's plant in Essington, Pa.

Dings Magnetic Separator Company, Milwaukee, Wis., announces the appointment of J. Max Lee, 114 West 17th St., Los Angeles, Calif., as sales representative in southern California.

Trade Catalogs

Valves and Gears—The following illustrated bulletins covering valves and gears have just been released by the Dominion Engineering Works, Ltd., Montreal, Que., Canada: No. 114 on tilting-disc check valves; No. 115 on Larner-Johnson values for water-works service; No. 116 on standard gate valves; No. 118 on Farrel-Sykes high-speed gear reducing and increasing units; and No. 112 on "Gearflex" couplings.

Pipe Bends—Specifications and prices of "Creflex" bends for welded piping are given in Bulletin W-101 of the Pittsburgh Piping and Equipment Company, 43rd St. & A.V.R.R., Pittsburgh, Pa. The bulletin also contains data on loose-flange welding stub ends and necks, forged tubular drip pockets, forged-steel butt welding flanges, short-radius pipe bends for butt welding, and miscellaneous "Durex" welding products.

Diesel Engines — Worthington Pump and Machinery Corporation, Harrison, N. J., has just released the following new bulletins on four-cycle direct-injection diesel engines: No. S-500-B5A covering 50 to 150 hp. sizes, No. S-500-S5 covering 150 to 300 hp. sizes, No. S-500-B7 covering 225 to 450 hp. sizes, No. S-500-S4 covering 300 to 600 hp. sizes and No. S-500-S6 covering 375 to 1,000 hp. sizes.

Motors and Switches — Several bulletins covering motors and switches have recently been published by the General Electric Company, Schenectady, N. Y. They are: No. 1580 on single-speed induction motors for elevator service; Nos. 19G, 1565, 1585, 1587 and 1588 on various types of magnetic switches for a.c. motors.

Wire Rope—A new bulletin illustrating and describing features of "Tru-Lay" wire rope has been issued by the American Cable Company, 230 Park Ave., New York, N. Y., under the title "The Cardinal Reasons Why You Save Money With Tru-Lay."

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Bakersfield—E. J. Symmes, Haberfelde Bldg., Archt., preparing preliminary plans for construction of a refrigerating plant. Estimated cost $50,000. Owner's name withheld.

Calif., Los Angeles—Department of Water & Power, will soon award contract for construction of a 2 story, 50 x 95 ft. electrical distribution station at 6775 Hawthorne Ave. Estimated cost $110,000. Specification 2774.

Colo., Colorado Springs — City, c/o E. L. Mosley, Mgr., awarded contract for 6,000 sq.ft. condenser to Ross Heater & Manufacturing Co., for steam power plant addition, also received lowest bid for 5,000 kw. turbine generator from Elliott Co., Ridgeway, $69,480. No award yet. Bids later on construction of building.

Ill., Chicago—Treasury Department, Office of J. A. Wetmore, Acting Supervising Architect, Washington, D. C., will receive bids until May 27 for addition to and remodeling of 4 story marine hospital, including X-ray department, laboratories, additions to boiler house, laundry and garage buildings on Clarendon Ave. Thielbar & Fugard, 520 North Michigan Ave., are architects.

Ill., Whitehall—City plans construction of a municipal electric light and power plant. Estimated cost $70,000. Russell & Axon, 6200 Easton St., St. Louis, Mo., are consulting engineers.

Ind., Alexandria — City will build a new municipal electric light and power plant. Estimated cost $40,000. J. W. Moore, Knights of Pythias Bldg., Indianapolis, is engineer.

Ind., Muncie—Ball Teachers College, will soon award cnotract for remodeling boiler plant including new equipment. Estimated cost $40,000. C. R. Ammerman, 924 Continental Bank Bldg., Indianapolis, is engineer.

Ind., Terre Haute—Vigo Ice Co., plans reconstruction of an ice manufacturing plant. Estimated cost $40,000.

Ia., Atlantic — City Council, T. E. Nichols, Clk., considering plans for improvements to municipal light plant including new $20,000 high pressure boiler. Total cost $35,000.

Ia., Lenox—City, L. B. Carruther, Clk., will receive bids until May 16 for construction of a 38 x 50 ft. power plant including two Diesel engine generating units, etc.

Ia., Sioux City—Sioux City Gas & Electric Co., plans to remodel power plant in North Riverside to use natural gas instead of coal as fuel, also seven mile gas mains. Equipment to cost $100,000. Total cost $200,000.

Md., Baltimore—Treasury Department, Office of Supervising Architect, Washington, D. C., awarded contract for construction of main building, power house, garage and laundry building at U. S. Marine Hospital here to W. E. O'Neil Construction Co., 308 West Washington St., Chicago, Ill. $809,900.

Mass., Swampscott—Town, having plans prepared for addition to pumping station on Humphrey St. Estimated cost $15,000. W. Pratt, Town Hall, is engineer.

Minn., Lakeville—Village Council, M. B. Berris, Clk., considering plans for construction of a municipal light and power plant.

Minn., Minneapolis—General Electric Realty Co., 120 Broadway, New York, completing plans for construction of a 3 story, service station, shop and office at Washington Ave. S. to Second St. Estimated cost $500,000. Private plans. General Electric Co., River Road, Schenectady, N. Y., lessee.

N. J., Lakehurst—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until May 11 for construction of an automatic refrigerating plant, cool rooms and drinking fountain system at Naval Air station here. Estimated cost $40,000. Private plans.

N. J., Newark—Newark Memorial Hospital, F. R. Hausling, Pres. of medical staff, 340 Bank St., plans construction of a 10 story hospital including steam heating system, etc., at Newton and Bank Sts. Estimated cost $1,000,000. Guilbert & Betelle, 20 Branford Pl., are architects.

N. Y., Middletown—Zwick & Schwartz, 12 Union St., awarded general contract for construction of a 1 story produce warehouse and refrigeration plant to Trojan Construction Co., 374 Bedford Ave., Brooklyn, $40,000.

N. Y., New York—S. Haddad, 1133 Broadway, will soon award contract for alterations to storage building, boiler room, etc., at 51 Orchard St. A. J. Simberg, 1133 Broadway, is architect.

N. Y., Oswego—G. C. Leitch, of Toronto Elevators Construction Co., Inc., Ltd., 200 Bay St., will receive bids until May 15 for construction of a new grain elevator, 2,000,000 bu. capacity here.

N. C., Charlotte—Station W.B.T. Inc., Nation's Ford Road, controlled by Columbia Broadcasting Co., 485 Madison Ave., New York, N. Y., awarded contract for equipment for radio station to R.C.A. Victor Co., Inc., R. G. Beerbower, Superv. Engr., 153 East 24th St., New York, $100,000; also enlarging radio power station to Southeastern Construction Co., Charlotte, $20,000.

O., Cincinnati — Cincinnati Union Terminal Co., H. M. Waite, Ch. Engr., 1020 Temple Bar Bldg., will soon award contract for construction of a 3 story, 42 x 492 ft. yard service building including steam heating system, etc., at Union Terminal. Estimated cost $270,000.

O., Eaton—Town repealed ordinance declaring necessary erection of municipal light plant and ordinance providing issuance of $233,000 mortgage bonds. Fosdick & Hilmer, Union Trust Bldg., Cincinnati, are engineers.

O., Miamsburg — Village, C. A. Hamilton, Service Director, 806 Union Trust Bldg., Dayton, will soon award contract for waterworks improvements including well, pump house, 700 g.p.m. pump compensator for 60 hp. motor, etc.

Ore., Bend—Great Northern Railway Co., St. Paul, Minn., having plans prepared for construction of a 2-stall engine house and power house here. J. R. W. Davis, St. Paul, Minn., is chief engineer.

Tex., Longview—United Gas Public Service Co., Houston, has been granted permit to construct compressor station, four units of 165 hp. each. Estimated cost $60,000. Private plans.

Va., Roanoke—Chesapeake & Potomac Telephone Co. of Virginia, C. H. Weber, Gen. Mgr., 703 East Grace St., Richmond, plans construction of a new 3 story, 85 x 140 ft. telephone building, including installation of underground cables, radio terminal equipment for transmission of broadcasting programs, teletypewriter equipment, etc., at Luck Ave. and Third St., here. Estimated cost $1,700,000.

Wyo., Buffalo — State Highway Commission, will soon award contract for constructing a 12 x 20 ft. boiler house, 42 x 84 ft. shop and garage building. Talcott Moore, Sheridan, is district engineer.

Equipment Wanted

Air Compressor—Washington, D. C.—Chief of Engineers, Munitions Bldg., will receive bids until May 20 for air compressors, centrifugal pump, etc. Cir. 32.

Engines and Generators — Columbus, Ind. — City, F. Owens, Clk., will receive bids until May 21 for installation of Diesel engines and generators in municipal light plant.

Engine, Pump, etc. — Quincy (br. Boston), **Mass.**—Commonwealth of Massachusetts, Metropolitan District Commission, will receive bids until May 19 for vertical pumping engine, condenser type, non-clogging centrifugal pump, 15 m. gal. capacity for Quincy waterworks pumping station, South Metropolitan system.

Generator Unit—Anoka, Minn.—C. R. Erickson, State Purchasing Commissioner, State Capitol, St. Paul, will receive bids until May 17 for 150 kw. engine-generator unit for power plant at State Asylum here.

Generators—Brooklyn, N. Y.—Signal Supply Officer, Army Base, will receive bids until May 27 for equipping nine to twelve prime movers with generators. Cir. 135.

Ice Plant Equipment—Columbus, O.—Department of Public Welfare, 9th and Oak Sts., T. S. Brindle, dir., will receive bids until May 27 for ice plant ammonia system, 20 tons daily capacity, also creamery equipment including aerator cooler, 600 gal. daily.

Power Plant Equipment—Lincoln, Neb.—City, T. H. Berg, Clk., will receive bids until June 1 for power plant equipment including 4,000 kw. turbo-generator and switchboard, cooling water circulating pump, electric driven condensate removal pump, steam turbine and steam jet air pumps, for A. street pumping station. Estimated cost $120,000.

Pump—Hot Springs, Ark.—Constructing Quartermaster, Army and Navy General Hospital, will receive bids until May 24 for horizontal centrifugal pump with starter and control equipment.

Pump—Montana—Constructing Quartermaster Ninth Corps Area, Fort Mason, San Francisco, Calif., will receive bids until May 20 for furnishing and installing 60 g.p.m. motor driven pump, etc., in present pump house in connection with electric power line and water system at Custer Battlefield National Cemetery, Crow Agency, Big Horn County here.

Pump and Motor—Ames, Ia.—City, J. H. Ames, Mgr., will soon receive bids for pump and motor for sewage disposal plant.

Pump and Equipment—Ann Arbor, Mich.—City, F. C. Perry, Clk., plans to purchase electric motor driven centrifugal pump and equipment in connection with waterworks improvements. Estimated cost $25,000.

Pumps—Colby, Kan.—City will receive bids until May 19 for pumps, etc., in connection with sewage treatment works.

Industrial Projects

Calif., Van Nuys—John D. Gregg, plans construction of a cement products plant near here. Estimaetd cost $750,000.

N. J., Hoboken—Hinde & Dauch, 253 Water St., Sandusky, O., awarded contract for construction of a 1 story, 160 x 700 ft. paper manufacturing plant at Monroe and Madison Sts. between Ninth and Eleventh Sts., to Otto Randolph Inc., 53 West Jackson Blvd., Chicago. Estimated cost $400,000.

N. Y., Long Island City—National Sugar Refining Co., 55th Ave. and Second St., plans alterations to power house. Estimated cost to exceed $25,000. L. T. Bromfield, c/o owner, is engineer.

N. C., Durham—Erwin Cotton Mills, awarded contract for a 64 x 100 ft. addition to mill to Muirhead Construction Co., Durham.

O., Cleveland—Cleveland Heater Co., Locust Ave., plans two additions to plant, 1 and 2 story, 100 x 140 and 100 x 200 ft. Estimated cost to exceed $60,000. George S. Rider & Sons, Marshall Bldg., are architects.

O., Piqua—Piqua Handle & Manufacturing Co., manufacturers of woodworking equipment and novelties, plans to rebuild plant destroyed by fire. Estimated cost $40,000. Maturity indefinite.

O., West Carrollton—West Carrollton Parchment Co., awarded contract for addition and extensions to paper mill to Charles H. Shook, c/o owner. Estimated cost $40,000.

Wash., Bellingham — Consolidated Furniture Manufacturing Co., 380 Eugene St., Portland, Ore., has work under way on construction of a furniture factory here. Estimated cost $75,000. Work by day labor under supervision of owners.

Ont., Kitchener—Wunder Furniture Co., 280 Victoria St., plans to rebuild furniture factory recently destroyed by fire. Loss $100,000. Interested in prices on woodworking machinery, etc.

Ont., Port Alfred — Consolidated Power & Paper Co., plans to rebuild part or all of plant destroyed by fire. Estimated cost exceeds $1,000,000. Maturity indefinite.